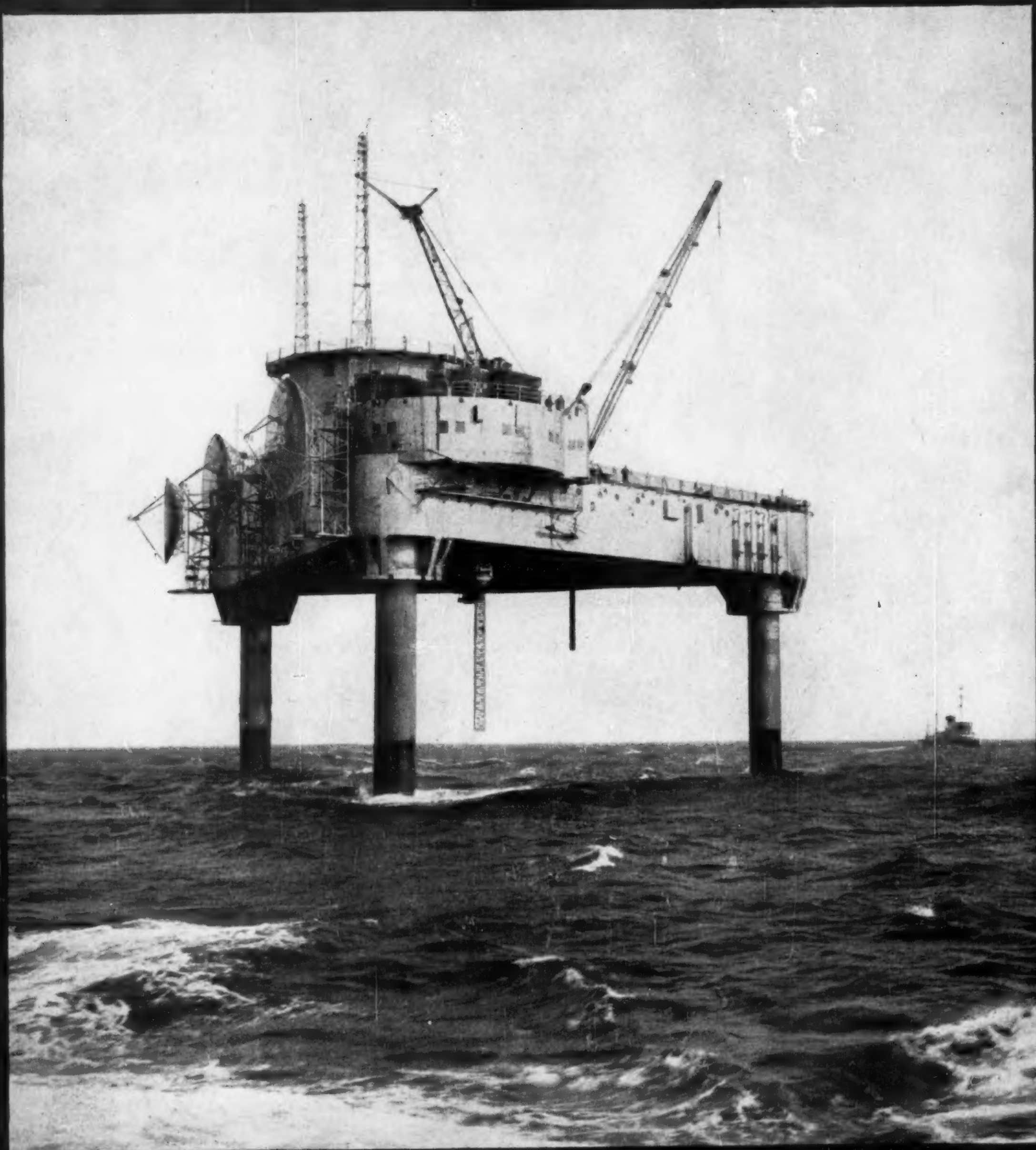
CIVIL ENGINEERING

JANUARY 1956

THE MAGAZINE OF ENGINEERED CONSTRUCTION



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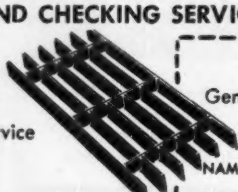

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CIVIL ENGINEERING

JANUARY 1956
VOL. 26 • NO. 1

THE MAGAZINE OF ENGINEERED CONSTRUCTION

• ARTICLES

• SOCIETY NEWS

• NEWS BRIEFS

• DEPARTMENTS

Announcing New Complete S-A

S-A Modern Stā-Bilt Method of Road Stabilization

SEAMAN TRAV-L-PLANT and PULVI-MIXER build better road bases through faster, more thorough, accurately controlled in-place mixing — a normal production rate of up to A MILE A DAY of 22-foot road! Exclusive advantages include: Mixing for *all* types of stabilization including bituminous, soil-cement, gravel, or chloride, both sodium and calcium. Blending and properly placing aggregates and fines for more durable, higher loadbearing bases. Completely correcting aggregate segregation. Mixing, blending and finishing to final grade, partially pre-compacted ready for final rolling.

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Designed for highly accurate application of all binders, including water and bitumen, simultaneously with mixing operations. Equipped with pump, spray bar, tachometer assemblies, volumetric meter. All operating controls within quick easy reach. A perfect, *all-process* machine for economical mix-in-place operations. 7-foot mixing width, gasoline or Diesel powered.

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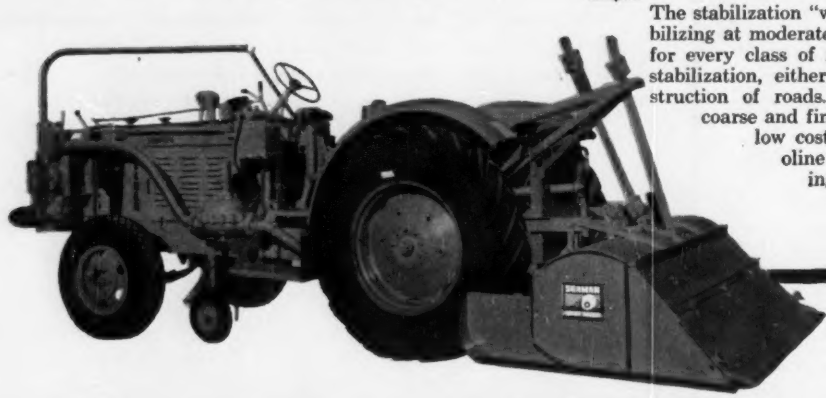
The stabilization "workhorse" for all types of stabilizing at moderate investment. Widely accepted for every class of mixing and processing of soil stabilization, either new construction or re-construction of roads. Delivers accurate blend of coarse and fine aggregate — for all-weather, low cost, long-wearing surfaces. Gasoline or Diesel powered. 7-foot mixing width.



New SEAMAN-ANDWALL Portable and Self-Propelled Rollers and Compactors offer many new advantages in road building . . . Greater visibility and maneuverability, easier transport to the job, plus many new features that assure superior compaction, more accurate rolling — without surface sheer, scuffing, or material displacement. Choice of models for every type of operation, every contractor.

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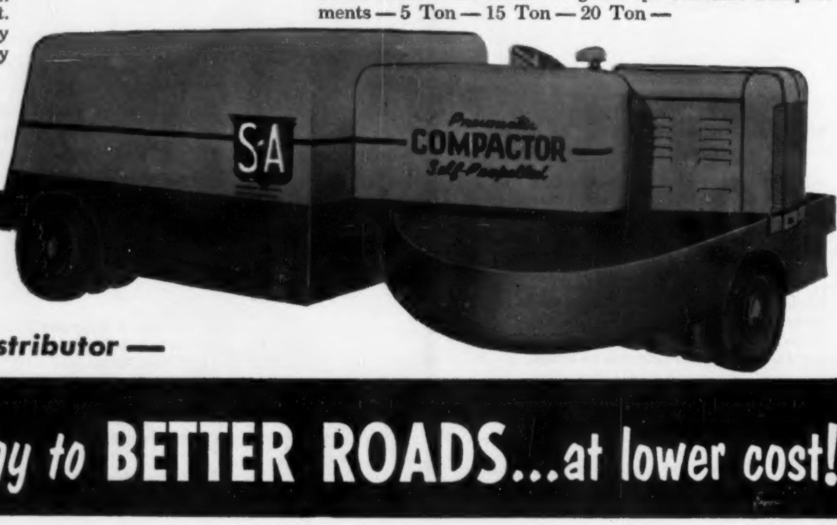
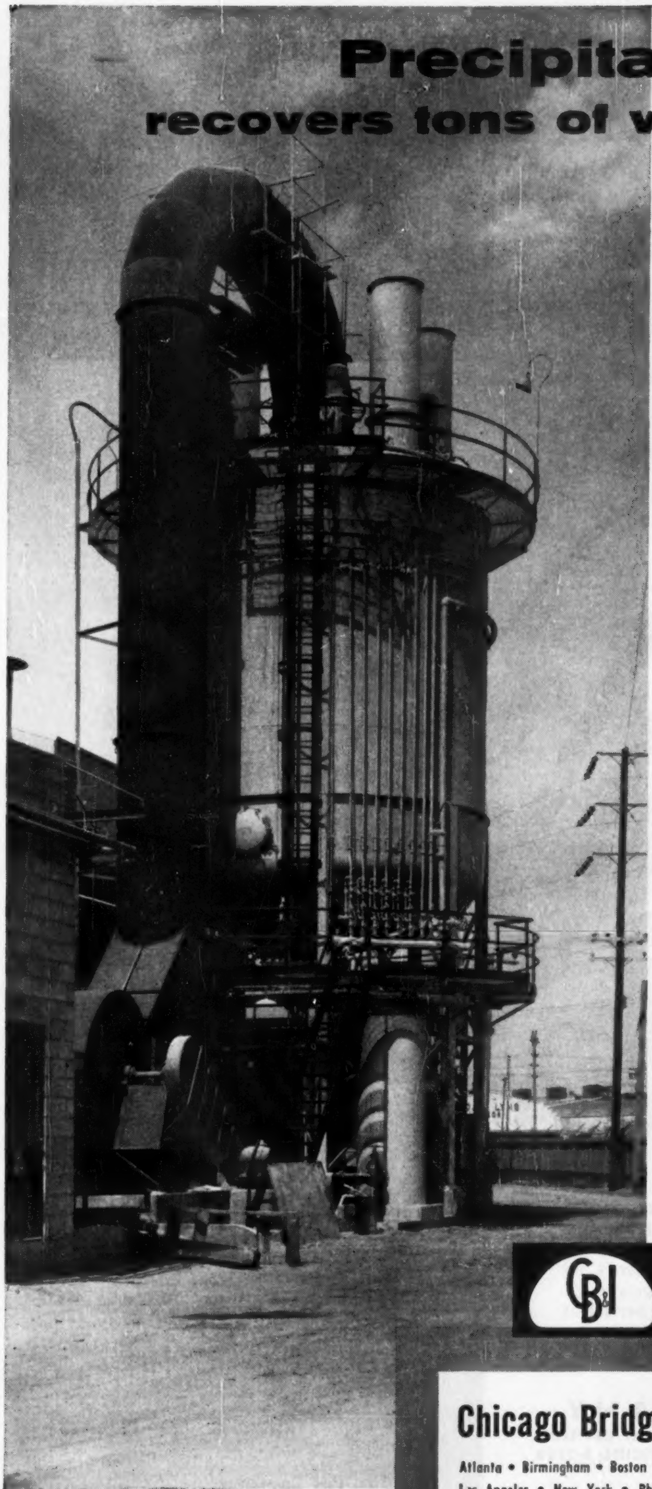
Revolutionary new design in heavy duty rubber tire rollers. Self-propelled for transport road speeds up to 20 m.p.h. Provides new "straight down" pressures . . . eliminates usual pushing action, surface shear, scuffing, material displacement. Power steering — full 180° turn on 20-foot road beds. Four 500-gal. Liquid Ballast Compartments — 5 Ton — 15 Ton — 20 Ton —



See your S-A Distributor —

Open the way to BETTER ROADS...at lower cost!

Precipitator Shell
recovers tons of valuable ore dust



.....another example of CB&I special steel plate work

Shown at left is a precipitator shell built by CB&I for use at a barium chemicals plant. The precipitator was installed to recover valuable barium dust that is produced during furnace operations. Tests prove that the precipitator recovers over 95% of the material fed to it, or roughly two tons per day.

This is one example of the wide range of steel plate structures that CB&I is equipped to build. Also, we regularly build elevated water tanks and pressure storage vessels.

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There is no substitute for Austin-Western quality.

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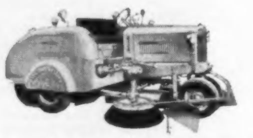


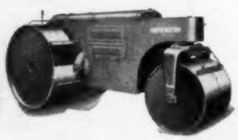
Model "40" Motor Sweeper

Tandem Roller

Self-Propelled Hydraulic Crane

4x4 Power Graders (88-L and 99-L)

6x6 Power Graders (Super 88 and Super 99)



3-Wheeled Roller

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Power Graders · Motor Sweepers

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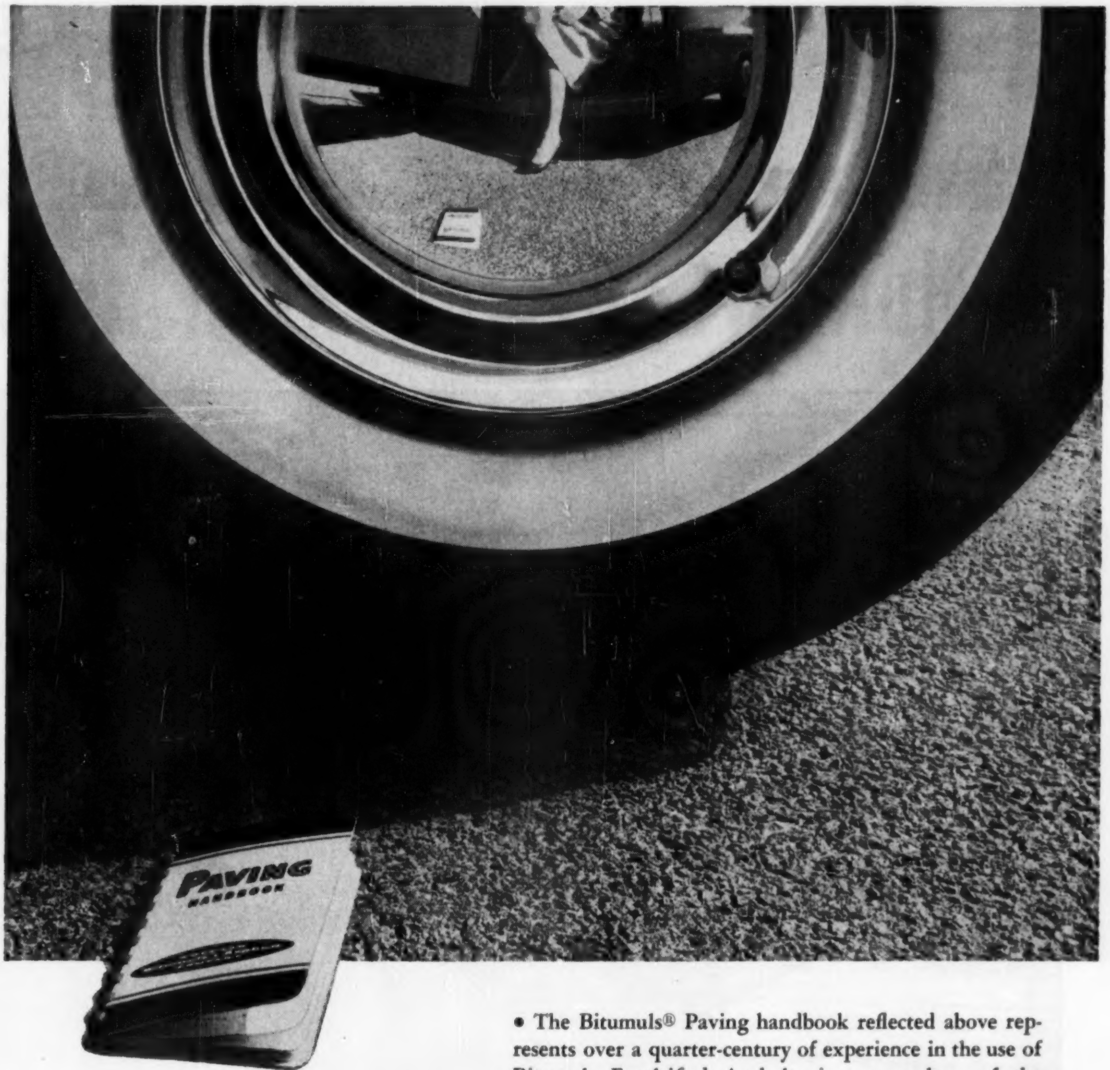
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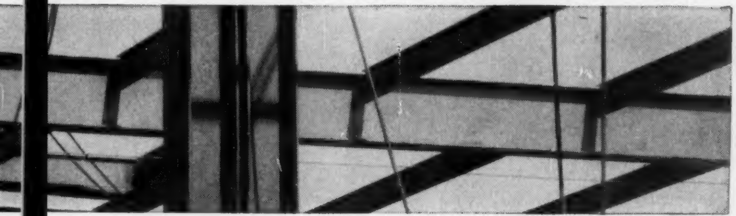

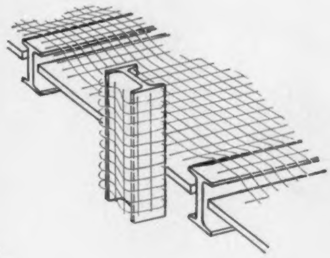

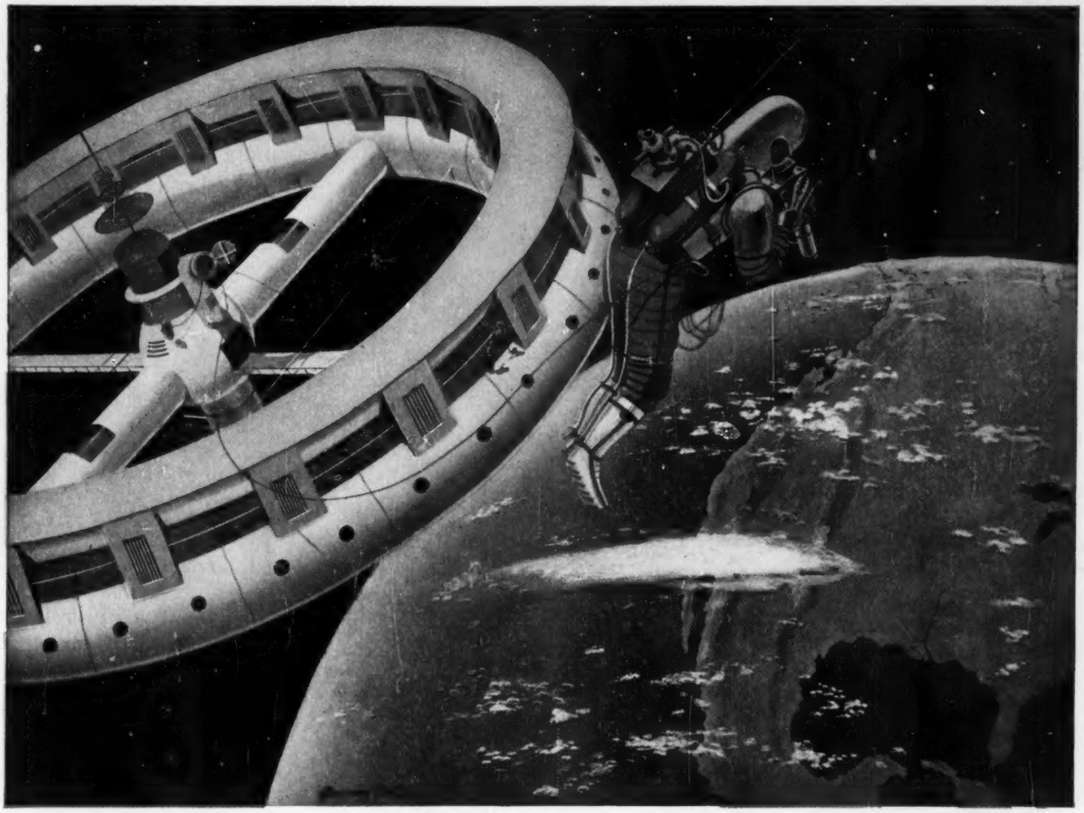

A SPACE STATION . . . a thousand miles high in the stratosphere slowly circling the globe . . . observers near its rim studying cloud formations and the earth's atmospheric conditions below . . . this may be our weather bureau of the future.

100 years from now... A MAN-MADE "MOON" MAY BE OUR WEATHER BUREAU

OUR WORLD of tomorrow will bring many changes. But in one vital aspect of American living, your great-grandchildren will continue to enjoy the same dependability and service you know today. *Cast iron pipe laid today will still carry water and gas to their homes.*

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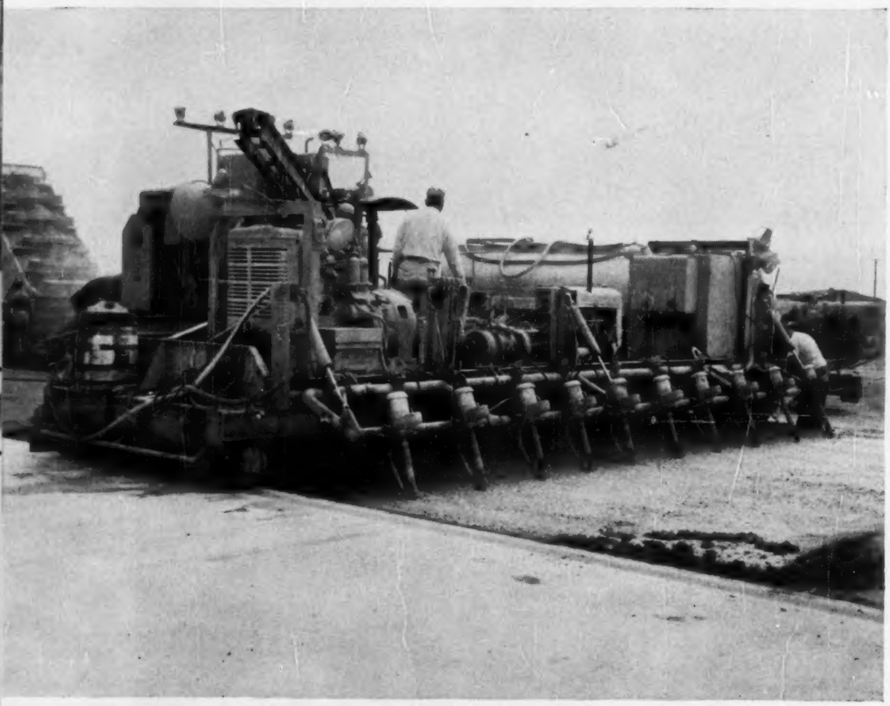
A wholly integrated producer from mines and blast furnaces to finished pipe.

A PICTURE REPORT OF

INTERNATIONAL POWER

Boosting job production everywhere

Morrison-Knudsen Co. and Landers & Griffin Inc., joint venturers on $17,000,000 Portsmouth (New Hampshire) Air Base, are laying 423,000 cu. yds. of concrete with this spreader. Its 10 International-powered vibrators continuously work a strip 25 ft. wide, 14 inches thick. All concrete is being laid for 200 x 11,620 ft. runway and 1,000 x 8,500 ft. apron. Also on the 5,788,000-yd. job are 6 TD-24 torque converter pushers and 16 self-propelled scrapers. Their output on 10,000-ft. cycles averages 1,400 pay yds. hourly.



This International "300" tractor is economically doing a job normally assigned a much bigger, more expensive machine . . . moving 1000 cu. yds. Heaping 8 cu. ft. of sandy loam per load, it completes a 100-ft. cycle every 1½ minutes. "300" is building a running track for a school in Greenville, Mississippi, will take 7 to 10 days.

3000-ft. cycle every 3 min. is the record of Western Construction Co's "55" Payscraper. This includes time for TD-24 to push-load 10 pay yds. of ripped caliche. Area, near El Paso, Texas, was once considered too steep and rocky for development. Soon, thanks to International power, it will be graded and terraced for 250 quarter-acre lots.

NEWS OF ENGINEERS

William R. Glidden, assistant chief engineer of the Virginia Highway Department and immediate Past President of ASCE, was recently honored at the seventh annual meeting of the Richmond Chapter, Virginia Society of Professional Engineers. He received a certificate citing him for his contributions in developing the organization in Virginia.

Draper K. Sutcliffe, formerly civil engineer with the Maryland Department of Public Improvements, and **Frederick Y. Ward,** formerly construction engineer with Whiting and Turner Contractors, recently formed a partnership to practice land surveying. The new firm, under the name of Sutcliffe and Ward Surveying Service will have offices in Baltimore and Bel Air, Md.

Arvon L. Davies has recently been appointed coordinator for overseas development for the Chemstrand Corp., Decatur, Ala. At the time of his appointment, he was serving as assistant to the president, and will continue in that capacity. He joined the company in 1951, after employment in a similar position with the Merritt-Chapman and Scott Corp.

Charlie G. Beckenbach, Colonel, U. S. Army, Dallas, Tex., has been added to the Seventh Army staff in Vaihingen, Germany, as chief of the movements division of the Transportation Section. He comes from a similar assignment with Second Army Headquarters, Fort George G. Meade, Md. Colonel Beckenbach is president of the U. S.-British-French Liaison officer group, representing commanders of those forces in transactions with German railroads. He previously served in Japan and Greenland.

C. G. Beckenbach

Peter J. Doanides, formerly chief engineer of the Roberts Construction Co. and president of the Concrete Development Corp., Ltd., both of Johannesburg, South Africa, has been appointed executive vice-president of Vacuum Concrete, Inc. of Philadelphia. Mr. Doanides, who designed and constructed some of the world's largest precast prestressed concrete water storage tanks in Johannesburg, has also been active in construction of various concrete structures for the South African gold mining industry. He recently received his engineering doctorate from the University of Athens.

Franklin O. Rose has returned to educational work again as guest professor of civil engineering at Birla College of Engineering, Pilani, India, having signed a contract with the University of Wisconsin to teach there under their arrangement with I.C.A. He has recently been in Navy service stationed at San Juan, Puerto Rico.

J. Donovan Jacobs, chief engineer for the Kaiser-Walsh-Perini-Raymond joint venture on the Snowy Mountain project in Australia, has announced the establishment of a consulting office with headquarters in San Francisco.

Harold B. Pullar is now president of Rubarite, Inc., of Chicago. He has been associated with the Berry Asphalt Company of Magnolia, Ark., for 28 years, from 1947 until recently as president. Mr. Pullar is also a director of Bird & Son, Inc., of which Berry Asphalt is a subsidiary.

Appointment of **John W. Vickrey** and **Charles E. Waite** as deputy state highway engineers has been announced by the California Division of Highways. Mr. Vickrey will serve as deputy for engineering and Mr. Waite as deputy for administration and management. Both have been serving as assistant state highway engineers and were selected for promotion from a newly established Civil Service list. **J. C. Womack,** planning engineer, succeeds Mr. Vickrey as assistant engineer.

Walter L. Willig, professor of civil engineering and assistant dean of the School of Technology at City College of New York and resident of Port Chester, N.Y., has been appointed president of Staten Island Community College by the State University of New York. Staten Island Community College is scheduled to open next September with 200 students, and will be administered by the City Board of Education under the State University.

Donald S. Berry, since 1948 professor of transportation engineering at the University of California, has joined the faculty of Purdue University, effective January 16, 1956. In his new capacity Dr. Berry will teach traffic engineering and coordinate the academic programs at graduate and undergraduate levels in the field of transportation engineering.

Jacob L. Crane, consultant of Annapolis, Md., is again visiting Greece, Iraq and Egypt, where he is consulting on resettlement and housing.

Mario G. Salvadori, professor of civil engineering at Columbia University, has joined the office of Paul Weidlinger, New York City consulting engineer, as an associate. Dr. Salvadori is the author of several books on engineering mathematics and has contributed numerous research papers on engineering mechanics to American and foreign journals. In 1954 he was granted an honorary degree in engineering in Brazil.

Mario G. Salvadori

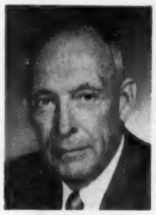
(Continued on page 25)

News of Engineers

(Continued from page 23)

John T. Robinson, consulting engineer, announces the formation of a consulting firm for the practice of civil and sanitary engineering. Headquarters for the new firm will be in Corona Del Mar, Calif.

Joseph W. Barker, chairman and president of the Research Corporation, New York City, was inducted into office as president of the American Society of Mechanical Engineers at its recent Diamond Jubilee Annual Meeting held in Chicago. Dr. Barker was dean of engineering at Columbia University from 1930 to 1946, and served during the war as special assistant to the Secretary of the Navy in charge of all naval education and training policy.



Joseph W. Barker

Jacob Feld, consulting engineer, New York City, was awarded the D. B. Steinman prize for research in structural engineering by the New York Academy of Science at its annual meeting held December 1. Dr. Feld was cited for his work on structural design studies for radio telescope with 600-ft diameter paraboloid reflector. This is the first award of the prize made by the Academy.

John F. Seifried, Chicago district manager of Ceco Steel Products Corp., of Chicago and member of the firm's board of directors, is retiring after more than 35 years of service. He will remain in an advisory capacity with the company's Chicago district sales corporation. Mr. Seifried served for two terms as president of the Illinois Section of the Society.

Henry Aaron, formerly connected with the Airports Technical Branch of the Civil Aeronautics Administration, Washington, D.C., has been named highway and airport engineer of the Wire Reinforcement Institute, Washington, D.C. Mr. Aaron has been with the C.A.A. since the end of the war, in which he served in the U.S. Navy as public works officer. In his new position Mr. Aaron will work with highway and airport engineers throughout the country to develop standards and specifications for the reinforcement of portland cement concrete pavement with steel welded wire fabric.

Robert B. Brooks, consulting engineer of St. Louis and former Director and Vice-President of ASCE, was recently elected vice-chairman of the ten-man Missouri delegation of the Mississippi River Parkway Planning Commission. The commission's purpose is to plan the Missis-

(Continued on page 27)

News of Engineers

(Continued from page 25)

sippi River Parkway from the source of the river at Lake Itasca to a probable junction with the Inter-Canadian Highway at Kenora, Canada, thence along the river to New Orleans and the Gulf of Mexico. Preliminary government surveys for this route have been made through the Bureau of Public Roads and the National Park Service.

Louis A. Pick, Lieutenant General, U.S. Army, and retired Chief of Engineers, has been elected chairman of the board of directors of the John J. Harte Co., architects, engineers, and construction managers, of Atlanta, Ga. General Pick was Chief of Engineers from 1949 until his retirement from the Corps of Engineers in 1947 after 37 years of service.

Three California engineers—**Guy F. Atkinson,** San Francisco, **Nathan Bowers,** Atherton, and **Julian Hinds,** Santa Paula, Calif.—were among thirteen engineers to be honored by the Beavers organization "for outstanding achievement in the heavy, engineered construction field." They will receive awards at the group's first annual dinner to be held at the Hotel Statler, in Los Angeles, January 27. The Beavers was formed to recognize outstanding achievement in the heavy construction industry, and consists of members active in that area west of the Mississippi.

Harvey O. Banks, assistant state engineer of California, Sacramento, has been named temporarily to the post of California state engineer pending selection of a permanent successor. During his interim appointment, Mr. Banks will continue his regular duties as assistant state engineer in charge of water right and water quality investigation.

Lewis B. Combs, Rear Admiral, CEC, U.S.N. (retired), head of the civil engineering department of Rensselaer Polytechnic Institute, was recalled to active duty during the past summer for the purpose of an inspection trip to the European areas where CEC officers are on duty. He inspected the Spanish Base Construction Program, the Joint Construction Agency, and Naval installations and activities in England.

Robert J. Hansen, Myle J. Holley, Jr., and **John M. Biggs** have become associated in a partnership under the name of Hansen, Holley, and Biggs. The firm, which will be located in Cambridge, Mass., specializes in structural engineering.

Denman K. McNear has taken over new duties with the Southern Pacific Co. as trainmaster at Tucumcari, N. Mex., on the Rio Grande Division. Formerly, Mr. McNear was assistant division engineer of the Sacramento Division and construction engineer for the system with headquarters at San Francisco.

Non-ASCE Meetings

American Concrete Institute. Fifty-second annual convention at the Bellevue-Stratford Hotel, Philadelphia, Pa., February 20–23. Further information from ACI, 18263 West McNichols Road, Detroit 19, Mich.

American Institute of Electrical Engineers. Winter general meeting at the Statler Hotel, New York, N.Y., January 30 through February 3. Details from AIEE, 33 West 39th St., New York 18, N.Y.

American Institute of Mining and Metallurgical Engineers. Annual meeting at the Statler and New Yorker Hotels, New York, February 20–23. Annual dinner at the Waldorf-Astoria, February 22. Information from AIME, 29 West 39th Street, N.Y. 18, N. Y.

American Road Builders' Association. Fifty-fourth annual convention at Municipal Auditorium, 1700 Washington Ave., Miami Beach, Fla., January 11–14. For information regarding hotels and programs write to ARBA, World Center Building, Washington 6, D.C.

American Society of Heating and Air-Conditioning Engineers. Sixty-second annual meeting at the Sheraton-Gibson Hotel, Cincinnati, Ohio, January 23–25. Details from ASHA-CE, 62 Worth Street, New York 13, N.Y.

Chamber of Commerce of the United States. National conference on water resources policy, to be held in cooperation with Engineers Joint Council and the National Water Conservation Conference in St. Louis, January 24 and 25. Details from the Chamber of Commerce, Washington, D.C.

Columbia University. International Conferences on Fatigue in Aircraft Structure, Columbia University, New York City, January 30–February 1.

Engineers Joint Council. Second Annual General Assembly at the Hotel Statler, New York City, January 26 and 27. Details from EJC, 29 West 39th St., New York 18, N.Y.

Highway Research Board. Thirty-fifth annual meeting at the Sheraton-Park Hotel, Washington 8, D.C., January 17 through 20. Information from Highway Research Board, National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.

University of California. Eighth annual California Street and Highway Conference at University of California, Los Angeles campus, January 25–27. Lodging headquarters will be the Hollywood-Roosevelt Hotel, 7000 Hollywood Blvd., Hollywood. First Conference of Construction Operations, University of California, Los Angeles campus, January 27–28. Details from John M. Server, Jr., "Southwest Builder and Contractor," 1660 Beverly Boulevard, Los Angeles 26, Calif.

New Publications

Geologic terms . . . "A Glossary of Selected Geologic Terms"—compiled by W. L. Stokes and David J. Varnes for the Colorado Scientific Society—contains some 2,670 entries with special reference to their use in engineering. The style is semi-encyclopedic, with numerous digressions of interest to non-geological users. Inquiries should be addressed to the Colorado Scientific Society, P.O. Box 688, Denver 1, Colo. In paper binding copies are $2.75, and in cloth $3.50.

Construction summary . . . Data on construction volume and costs for the period, 1915–1954, make up an 80-page paper-bound statistical supplement to "Construction Review." The publication is a joint compilation of the Departments of Commerce and Labor. Copies may be ordered from the Superintendent of Documents, Washington 25, D.C., at 50 cents each.

Vehicle taxes . . . Truck operators pay one-third of all special automotive taxes levied in the nation, the Automobile Manufacturers Association reports in a new edition of its annual booklet, "Motor Truck Facts." The booklet shows that, while contributing 33 percent of motor vehicle taxes, trucks comprise only 17 percent of such vehicles on the highways and account for only 18 percent of the nation's total vehicular mileage. Inquiries about the 56-page publication should be sent to the Association's Motor Truck Committee, New Center Bldg., Detroit 2, Mich.

Structural engineering . . . Lehigh University's Fritz Engineering Laboratory announces the availability of 500 reprints of its Progress Report No. 5 entitled "Endurance of a Full-Scale Pretensioned Concrete Beam." The authors are K. E. Knudsen and W. J. Eney, M. ASCE. Copies are priced at $1.50 each, and inquiries should be addressed to the Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

Engineering research . . . The strength of the research program under way in our engineering colleges is affirmed in the 1955 "Review of Current Research and Directory of Member Institutions," issued biennially by the Engineering College Research Council of the ASEE. The 352-page publication covers 7,500 projects in the 105 member institutions of the ECRC, which includes all major engineering schools in the United States. Over 15,000 persons are engaged on these projects, and the annual cost is about $75,000,000. Copies of the directory at $2 each may be obtained from Renato Contini, Secretary ECRC, New York University, University Heights, New York 53, N.Y.

Building standards . . . Building codes throughout the United States and Canada have adopted, by reference, a large number of ASTM Standards as authentic sources of test procedure and as a basis for acceptable quality of materials and construction. For the convenience of persons using building codes, the ASTM has now combined all such reference standards under one cover. The 950-page compilation, including specifications, methods of testing, and definitions, may be purchased from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. The price is $6.00.

Residential construction . . . A study of slab-on-ground construction for residences—conducted by the Building Research Advisory Board for the Federal Housing Administration—is available from the BRAB. The 60-page report served as the background and basis for the FHA's revision of its Minimum Property Requirements for Slab-on-Ground Construction. Inquiries should be sent to the Building Research Advisory Board, 2101 Constitution Ave., Washington 25, D.C. The report is $2.00 a copy.

Prestressed concrete . . . Issuance of the 1955 edition of its "Bibliography on Prestressed Concrete" is announced by the American Concrete Institute. Expanded to 103 pages, the book now lists more than 2,100 American and foreign literature references on the subject, published from 1896 to 1955. The publication, which was prepared as a part of the work of ACI-ASCE Committee 323 on Prestressed Reinforced Concrete, sells for $2. Persons who purchased the 1954 edition may bring it up to date with a supplement of additional material, which is available at 35 cents. Requests should be sent to the American Concrete Institute, 18263 West McNichols Road, Detroit 19, Mich.

Hydraulic research . . . The current status of hydraulic and hydrologic research in the United States is summarized in a 198-page volume edited by Helen K. Middleton and issued as National Bureau of Standards Miscellaneous Publication 215. Data cover all active projects sponsored by private industry, universities, and the government, and include the project sponsor, project correspondent, a brief description, results, and publications. Copies are $1.25 each, and may be ordered from the Government Printing Office, Washington 25, D.C. Foreign remittances must be in U.S. exchange and should include an additional one-third of the publication price to cover mailing costs.

Stream sanitation . . . A comprehensive survey of the water resources of Florida with a detailed analysis and listing of the sources of pollution in each of the principal watershed areas has been made available by the Florida Engineering and Industrial Experiment Station. Identified as Florida Engineering Series No. 1, the study presents statistical analyses of stream-flow data gathered at 51 gaging stations in Florida. The authors are David B. Smith, A.M. ASCE, J. W. Wakefield, H. A. Bevis, and E. B. Phelps. Paper-backed copies are $1, and cloth copies $2 (plus mailing and handling charges of 10 and 15 cents, respectively). Orders should be sent to the Campus Shop and Bookstore, University of Florida, Gainesville, Fla.

Bridge construction . . . Design of a highway bridge for the Ohio Turnpike is detailed by Odd Albert, A.M. ASCE, associate professor of civil engineering at Polytechnic Institute of Brooklyn, in a recent bulletin, priced at $1.50. The design includes the effect of "frequency loading," movable loads, temperature stresses, wind stresses, and shrinkage and plastic flow on both substructures and superstructures. Also featured are a short review of the new design specifications for the turnpike; a chapter by D. H. Overman, M. ASCE, first assistant engineer of bridges, Ohio Department of Highways; and an explanation of the author's method of "Modified Slope Deflections." Inquiries should be addressed to Professor Albert at Polytechnic Institute of Brooklyn, Brooklyn, N.Y.

Building tests . . . In response to increasing interest in the evaluation or measurement of the performance of building construction, the ASTM has published the proceedings of a "Symposium on Methods of Testing Building Constructions" presented at its 57th annual meeting held in Chicago in June 1954. Identified as Special Technical Publication No. 166, the 132-page report is available from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. The price is $2.75.

Concrete . . . Of interest to engineers, architects, and contractors who are primarily concerned with projects involving structural concrete is "Recommended Specification for Portland Cement Concrete," as developed by the Technical Committee of the National Slag Association. Free copies are available from the National Slag Association, 613 Perpetual Building, Washington 4, D.C.

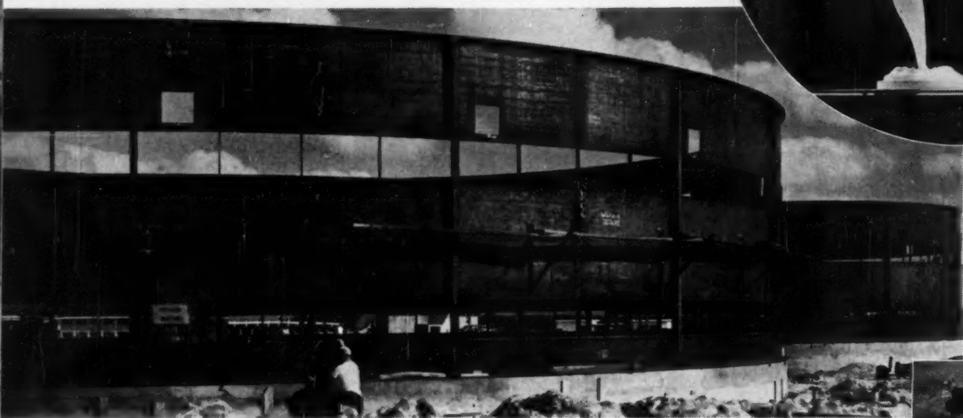
Hydraulic jump . . . Edward A. Elevatorski, hydraulic engineer for the U.S. Bureau of Reclamation at Albuquerque, N. Mex., has prepared a bibliography on the hydraulic jump and its related use. Covering the period from 1819 to 1953, this important reference contains over 500 domestic and foreign entries. Copies are available from the author at 2110 New York S.W., Albuquerque, at 75 cents each for purchasers in the United States and Canada and $1.00 elsewhere.

Giant Steel Fishbowls by

PITTSBURGH - DES MOINES

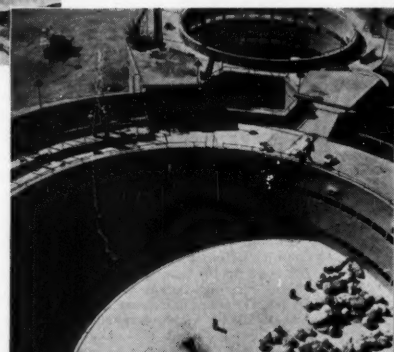
for the MIAMI

Entrance of the Seaquarium, on Rickenbacker Causeway, Miami, Florida

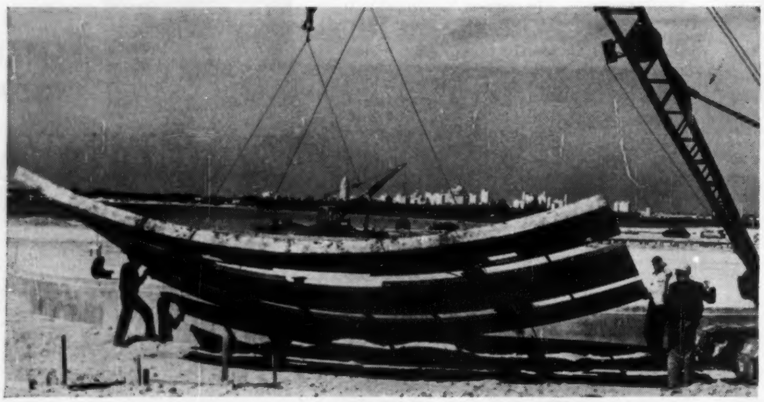


The steel aquaria under construction. 80 ft, 565,200-gallon tank in foreground, with 50 ft, 260,252-gallon tank in rear. Acclimating flume connects both tanks

One of the world's largest collections of tropical fish and marine animals is on brilliant display in Miami's new Seaquarium—with its great steel tanks fabricated and erected by Pittsburgh-Des Moines. The tanks are unique, with walls containing double rows of big show-windows, resting on concrete bottoms. • Many design and construction problems were encountered, requiring special solutions based on P-DM's broad engineering and construction resources. • Let us quote on your particular needs.



Aerial view, showing coral boulders on tank floor affording shelter for fish. Tiered outer decks afford visitors surface and underwater viewing



Prefabricated welded segment of tank goes into position on concrete base

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do you know that

The engineering problems of the new Tappan Zee Bridge began 170 million years ago? In those distant days, geologists say, a slippage of the earth's crust and erupting volcanoes created the geological conditions that make the Hudson one of the most difficult rivers to bridge. The three-mile structure across the Tappan Zee between Tarrytown and Nyack—dedicated on December 15—solves the foundation problem in this widest and most difficult part of the river with huge buoyant reinforced concrete boxes supporting a 1,212-ft cantilever span over the main channel. These boxes (the design of Emil Praeger, M. ASCE) support over 75 percent of the dead load of the bridge. Piles anchored in bedrock carry the rest of the load. The $60,000,000 bridge is the last link in New York's famous 427-mile Thruway.

Canada has nearly completed its share of Niagara power? The new Sir Adam Beck-Niagara Generating Station No. 2, near Chippewa, Ontario, will have a capacity of 1,680,000 hp from Niagara River at the Falls with water made available to Canada by the Treaty of 1950. Otto Holden, chief engineer of the Hydroelectric Power Commission of Ontario, describes the important project in this issue.

The building industry is safer than it used to be? This is the encouraging news William G. Rapp, assistant to the general manager of steel erection for Bethlehem Steel, gave the recent 43rd annual National Safety Congress. In the past ten years structural steel erection, once classed with the most dangerous occupations, has shown a decline from 82.7 to 25.9 in accident frequency rating and from 17.4 to 4.9 in severity rating. Sharing honors for the improved situation are building code revisions, equipment modification, and union emphasis on safety, according to Mr. Rapp.

It takes 600 members to man the ASCE Technical Division committees alone? Some of the Society's new Board and professional committee personnel are announced in the "Society News" section.

Radioactive water can be made safe to drink in 30 minutes? Army Engineers in the Research and Development Laboratory at Fort Belvoir have come up with a truck-mounted purification unit that eliminates water contamination from chemical, bacteriological, and radiological sources. The device can be put together by three men in less than 90 minutes and operated by one man, and its output of pure drinking water is about 3,000 gal per hr.

The concrete industry has more surprises in store? A proposed non-aqueous method of making portland cement, said to combine the best features of the wet and dry processes with potential savings in cost, is described in an article in this issue.

Within ten years it will be unusual for a large ship to be propelled by other means than atomic energy? This statement was made by John R. Dunning, dean of engineering at Columbia University and chairman of the recent Nuclear Engineering and Science Congress in Cleveland. The five-day Congress program and concurrent Atomic Exposition are reported in the "News Briefs" section.

The federal government is the largest single employer of engineers in the United States? In 1953 it accounted for about 11 percent of 633,000 American engineers said to be working. In 1954 about 68,800, or 8 percent, of the 843,100 federal white-collar workers were engineers. Source of these figures is Henry G. Armsby, Chief for Engineering Education, U.S. Office of Education, writing in a recent issue of "Mechanical Engineering."

Information for the 1956 Membership Directory is needed? Closing date for receiving information for the 1956 Membership Directory, now in the works, will be March 15. If you wish accurate and up-to-date personal information recorded in the Directory, please use the coupon on page 116.

The steel industry "is racing ahead on all fronts"? This is how the American Iron and Steel Institute sums up 1955 activities in the December issue of "Steel Facts." On the basis of returns for the first ten months of the year, the industry forecast is for a record production of over 115,000,000 tons of ingots and steel for castings. The best months, production-wise, were May and October, each with over 10,000,000 tons. Expansion programs that make this tremendous output possible include installation during the year of the first blast furnace with a hearth more than 30 ft in diameter.

CIVIL ENGINEERING

Trucks on South Loop exert tandem axle load of 32,000 lb on inside lane and 40,000 lb on outside lane.

RESULTS OF WASHO ROAD TEST

substantiate beam action in flexible pavements and value of paved shoulders

W. N. CAREY, JR., A.M. ASCE, Project Engineer, Highway Research Board, Washington, D.C.

The part of the Highway Research Board of the National Academy of Sciences in administration, direction of field work, and analysis and publication of findings in the WASHO Road Test is now completed, and the final report has been released.

Great masses of data were taken in the test and in post-test studies of the conditions of the subsurface pavement components. These data were thoroughly studied and analyzed in relation to the test pavement behavior and in relation to each other. Prior to their release, the analyses and the statements of findings were carefully considered in light of the observed and measured facts—by the staff and by an Advisory Committee made up of top research-minded engineers, primarily from the western

TABLE I. Total areas of distress at end of test, in sq ft

Lane	Sections Surfaced with 2-in. Asphaltic Concrete						Sections Surfaced with 4-in. Asphaltic Concrete				All Sections
Structure thickness	6 in.	10 in.	14 in.	18 in.	22 in.	Totals	6 in.	10 in.	14 in.	Totals	
18-kip single-axle	3,600	2,326	656	628	0	7,210	990	0	0	990	8,200
22.4-kip single-axle	3,600	2,996	901	41	0	7,538	1,784	8	0	1,792	9,330
32-kip tandem-axle	3,600	2,495	142	50	0	6,287	1,515	16	0	1,531	7,818
40-kip tandem-axle	3,600	3,600	1,244	507	59	9,010	2,186	223	161	2,570	11,580
All loads	14,400	11,417	2,943	1,226	59	30,045	6,475	247	161	6,883	36,928

Note: This is taken from Table 8-1, p. 203, "The WASHO Road Test, Part 2," Highway Research Board's Special Report 22.

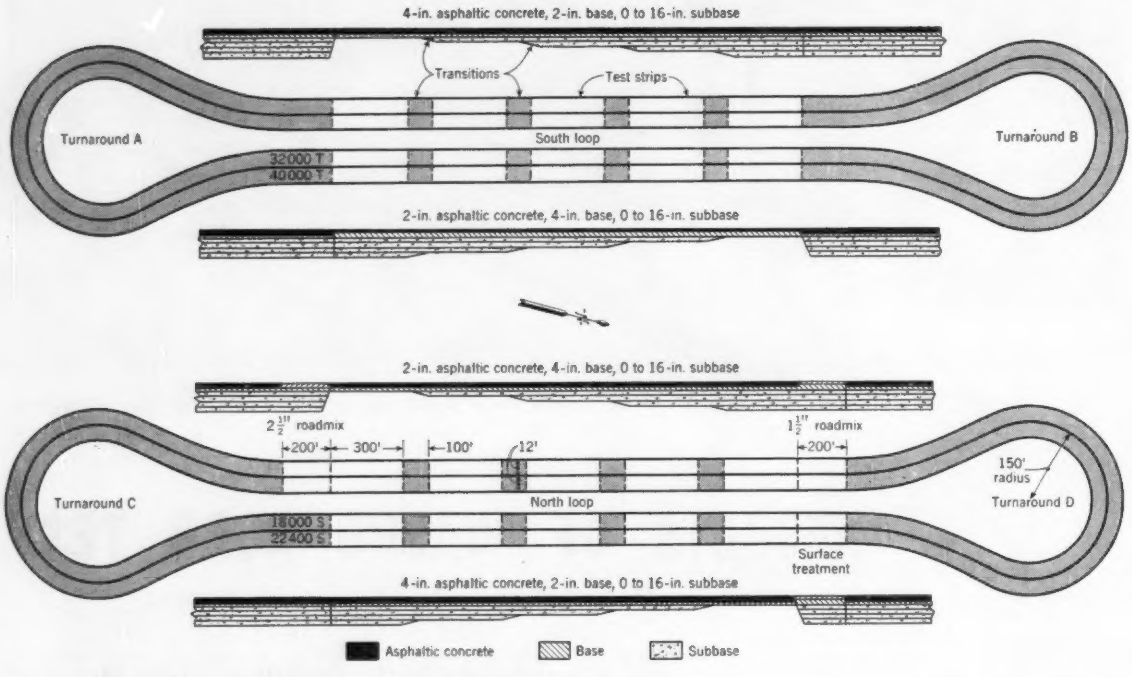


FIG. 1. Two test loops, North Loop and South Loop, were of same size in plan, with asphaltic concrete surfacing, base, and subbase varied as shown. (Taken from Fig. 1, p. 211, "The WASHO Road Test, Part 2," Highway Research Board Special Report 22.) South Loop carried all tandem-axle loads (32,000 lb on inside lane, 40,000 lb on outside lane) and North Loop all single-axle loads (18,000 lb on inside lane, 22,400 lb on outside lane).

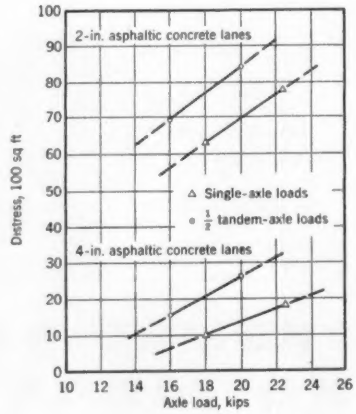


FIG. 2. Curves show relation between pavement condition and axle load. (Taken from Fig. 4-c-3, p. 96, "The WASHO Road Test, Part 2," Highway Research Board Special Report 22.)

Electronic deflection installation, seen ready for test, was used in analysis of distribution of deflection under moving loads.

states, who represented the sponsors of the test and the cooperating agencies.

What is the WASHO Road Test?

By way of background, the WASHO Road Test, named for its sponsors, The Western Association of State Highwas Officials, was a test conducted in southeastern Idaho of specially built flexible-type pavements under controlled truck traffic Cooperating in the test were the highway departments of eleven western states and Alaska, the Bureau of Public Roads, truck manufacturers of the Automobile Manufacturers' Association, members of the Truck Trailer Manufacturers' Association, members of the petroleum industry, and others. The total cost of the project was about $900,000.

The test area, in southeastern Idaho, was selected by the participants as representative of large areas of western states as to soil, climate, and other environmental factors. The project was located on the line selected for a rerouting and modernization of U.S. Route 191. Since completion of the research, the test tangents have been incorporated in the new highway.

Special test pavements representing what was considered to be normal design, over design, and under design for the environmental and traffic conditions were constructed in 1952 by a highly cooperative and efficient Utah contractor under rigid inspection and field control supervised by the Highway Research Board staff.

The test sections were laid out along the tangents of two practically identical loops, one for single-axle vehicles and one for tandem-axle vehicles (Fig. 1). The overall pavement structure thickness over the native basement soil was varied in 4-in. increments from 6 to 22 in. on each of the four tangents. The top 6 in. on one tangent in each of the two loops was constructed of 4 in. of hot plant-mix asphalt concrete and 2 in. of crushed gravel base of $^3/_4$-in. maximum size. The top 6 in. of the other tangent in each loop had 2 in. of plant mix and 4 in. of base. The remainder of the structure was made up of a 2-in.-maximum-size gravel subbase in thicknesses of zero, 4, 8, 12, and 16 in. Each test section was 300 ft long with two-lane (24-ft) paved surfaces. The shoulders of six of the sections were also paved, in 50-ft lengths, with hot plant mix for an additional width of 6 ft.

Gravel base and subbase were carried to the ditch slope at full depth. Adjacent test sections of different structure thickness were separated longitudinally by 100-ft transition sections, and the center lines of the two parallel tangents in each loop were 100 ft apart, connected at the ends by superelevated turnarounds of 150-ft radius. This geometric design permitted rather constant vehicle speeds of about 30 miles per hour (mph) over the test tracks.

Truck-tractor-semitrailer combination vehicles loaded with concrete blocks to single-axle loads of 18 and 22.4 kips were operated in the inner and outer lanes respectively of one of the loops, and tandem-axle loads of 32 and 40 kips were operated in the inner and outer lanes of the other loop. No vehicle with an axle load in excess of that specified for a particular lane was permitted to operate in that lane.

Test traffic operated at the same frequency in each of the four lanes—starting in November 1952 and stopping in May 1954—except that regular test traffic was discontinued during the winter and spring of 1952–1953 and during the winter of 1953–1954. During operating periods the trucks ran 18 hours per day, six days a week. In all, 238,-000 heavy axle loads were applied to each test section.

Aims of the project

The principal purpose of the research was to determine, if possible, the thickness of flexible pavement required to sustain each of these axle loads over a period of years under environmental conditions similar to those in the test area. In order to determine the answers to this and other similar questions, and in order to learn something of the mechanics of pavement failure, a comprehensive series of observations and measurements was undertaken. Instruments, by and large developed for the project, were provided to measure deflections of the pavements under moving loads, rutting or distortion in the wheel paths, transverse movement of the granular base materials, subsurface moisture content and temperature, etc. Daily observations by trained engineers were made of the appearance of the surfacing in each test section. Distress in the form of cracking of the asphalt concrete was carefully noted, and the progression of distress towards ultimate failure (in those sections where failure occurred) was recorded.

The test pavements were maintained by the application of skin patches, where necessary, as long as it was possible to do so. When the rate of distress formation was so rapid that skin patching became impractical, the area involved was removed from further study and the failed pavement rebuilt to high standards in order to carry the remaining test traffic to the unfailed sections without undue delay.

Those who would like more comprehensive and detailed descriptions of the project, the materials used in construction, the instrumentation, analyses of data, etc., are referred to the published reports. [See note at end of article.] It probably will be more useful here to discuss the findings of the test.

Because of the qualifying adjectives and phrases necessary to a true and complete presentation of each finding, the conclusions as stated in the report are not particularly well suited for presentation in shortened form. Therefore, since each statement has had such careful consideration, it is best that it be given as written in order to avoid the possibility of misunderstanding.

Results not revolutionary

First, perhaps a brief discussion of research of this type would be in order. One with only a casual interest in such things might expect a $900,000 test to bring forth some rather startling or revolutionary new concepts in highway building or design. Unfortunately this cannot be true. The number of controlled variables that can be studied thoroughly is limited. In this test the principal controlled variables were axle load and arrangement, and pavement structure thickness. In general the findings must be related to these things. Of course many other variables were also studied, as will be noted in the list of principal findings.

It has been said that a large part of the value of such research lies in the fact that it provides specific scientific proof of principles that were known or at least suspected by engineers prior to the test. For example, almost any engineer would concede that heavy loads would cause more damage than light loads or that thicker pavements would withstand heavier loads than thinner pavements. However, research with controlled variables is necessary in order that specific values may be assigned to the differences. Another value in this type of research that should not be overlooked is that it provides a stepping stone for similar future work. New techniques, new concepts, and new instruments are all given thorough field trials. This, of course, is a tremendous advantage to those planning new highway research.

In connection with this particular project, it must be pointed out that the conclusions or findings are applicable to the conditions prevailing at the test site during the life of the project. With due allowance for local conditions such as soil, weather, traffic, etc., certain relationships or trends indicated by the WASHO Road Test study may be used with confidence.

Principal findings listed

The principal findings of the WASHO Road Test are stated as follows:

1. On the basis of engineering analysis, the minimum thicknesses of pavement structure with 2-in. surfacing of asphaltic concrete that would have been adequate to carry the 238,000 applications for the four test loads, were 16, 19, 17 and 20 in. in the outer wheel path for the 18,000-lb and 22,400-lb single-axle, and 32,000-lb and 40,000-lb tandem-axle loads respectively. In the inner wheel path, the 14-in.-thick pavement sections were undamaged by any of the four loads. Comparable values for the 4-in. asphaltic-concrete pavement, outer wheel path, were 10 in. for the first three loads and 14 in. for the 40,000-lb tandem-axle load. For the inner wheel path, they were 6 in. for the two single, and 10 in. for the two tandem-axle loads.

2. The behavior of the pavement with the 4-in. surfacing was far superior to that of the pavement of equal structure thickness with the 2-in. surfacing of asphaltic concrete for the life of this test track.

3. Distress in the outer wheel path was considerably in excess of that in the inner wheel path. Surfacing of the shoulders in three of the test sections in July of 1953 proved to be highly effective in retarding distress in the outer wheel path. Both facts suggest that the outer wheel path with paved shoulders is the equivalent of the inner wheel path, and testify to the advantage of shoulder paving.

4. Development of structural distress in the pavement sections was confined largely to two critical periods of traffic operation. The most severe critical period in terms of rate of development of pavement distress started June 11, 1953, when test traffic was resumed for the summer and adverse subsurface conditions associated with the spring thaw were still present. In this period, June 11 to July 7, 1953, 27 percent (9,970 sq ft) of the total distress (36,928 sq ft) developed under 0.7 percent of the total test-load applications. Most of this distress occurred in the thin sections of 6-in. and 10-in. structure thickness. In the second period, February 17 to April 7, 1954, 40 percent (14,770 sq ft) of the total distress developed under 13 percent of the applications. Conversely, when conditions were favorable (that is, July 24 to November 21, 1953) 106,000 load applications (45 percent of the total) caused only 551 sq ft of distress, or approximately 1.6 percent of the total.

5. Although the weather was less severe than normal for the area, based on records of average temperature and total precipitation, it was considered reasonably representative of large areas of the West.

6. Based on distress that occurred in the section with 4-in. surfacing, a tandem-axle load of 28 kips would have been equivalent in this test to a single-axle load of 18 kips. Similarly, a tandem-axle load of 33.6 kips would have been equivalent to the 22.4-kip single-axle load. Comparisons for sections with 2-in. surfacing, based on a graphic analysis which discounted the relatively erratic behavior of two of the ten sections, showed that a tandem-axle load of 28.3 kips in this test could have been equivalent to the single-axle load of 18 kips. Similarly, a tandem-axle load of 36.4 kips could have been equivalent to the 22.4-kip single-axle load. In general, the distress caused by tandem axles was equivalent to that caused by single axles of the order of two-thirds of their weight. [See Fig. 2 and Table I.]

7. For this project the total area of all types of distress (from Class I cracks to deep patches) was 13.8 percent greater under the 22.4-kip single-axle load than under the 18-kip single-axle load, and 48 percent greater under the 40-kip tandem-axle load than under the 32-kip tandem-axle load.

8. Prior to the occurrence of total failure, distortion of the pavement evidenced by the formation of rutting in the wheel paths was confined primarily to the upper 6 in. of the structure. Moreover, the rutting which developed in the wheel paths was not necessarily associated with cracking.

9. Elastic deflections up to about 0.045 in. measured at creep speed were not associated with the development of distress in any of the sections during warm weather. During cold weather, deflections no greater than about 0.030 in. were not associated with distress. Repetitions of elastic deflections in excess of these values were responsible for cracking and eventual failure of the surfacing.

10. In so far as the condition of the basement soil was related to the performance of the test pavements, the moisture content of the uppermost layer was the most significant factor.

11. Penetration of the 32 deg F isotherm below the surface of the basement soil was approximately the same regardless of depth of covering structure, indicating that the structure materials had little or no insulating qualities.

12. Deflection of the pavement surface under traffic was influenced by vehicle speed, temperature of the surfacing, load, moisture content of the top layers of basement soil, and possibly by other factors. The deflection was maximum under a static load. Where the pavement surface was relatively smooth, deflections decreased as speed increased up to about 15 mph, after which deflections decreased but slightly as speed increased. Deflections were greater as the temperature of the surfacing increased. Deflections of the pavement surface under traffic were approximately proportional to the applied load. Tandem axles with a total load of approximately 1.8 times a single-axle load produced equal maximum deflections. It was found that deflections increased with increase in moisture content of the top layers of basement soil above 22 percent.

13. Asphaltic-concrete specimens from the test pavements had appreciable flexural strength when tested at a rate of loading equivalent to moving truck loading. Their strength varied with temperature and appeared to be higher at moderate temperatures than at extremely low or extremely high temperatures.

14. For the type of loading employed on the test road, there was no significant difference between the magnitudes of the wheel loads transmitted in the outer wheel paths and those in the inner wheel paths due to the crown of the test pavement.

That concludes the findings of the WASHO Road Test as published in Part 2 of the report. Most of the states in the West are already using some of this information in their present highway design considerations.

New large-scale test planned

I must not neglect to mention that the Highway Research Board has recently been selected to undertake the administration and direction of a new large-scale highway research project. This project, sponsored by the American Association of State Highway Officials, has been named the AASHO Road Test. All the state highway departments but one, the Bureau of Public Roads, members of the Automobile Manufacturers' Association, the Department of the Army, the Petroleum Industry, and others will cooperate in this $12,000,000 test. It will be similar to the WASHO test but much larger. Both rigid and flexible pavements will be tested under axle loads ranging from 10,000 lb on single axles to 50,000 lb on tandem axles, operating without interruption for 24 months. The project will be located near Ottawa, Ill., 80 miles southwest of Chicago, and the Illinois Division of Highways is now preparing the construction plans and specifications and

(Continued on page 102)

RAYMOND R. TUCKER, Mayor of St. Louis, Mo.;
Former Head, Department of Mechanical Engineering, Washington University, St. Louis, Mo.

The engineer in public life

Some may inquire just what I mean by "public life." I refer to those many hours of each day when we are expected to carry out our duties as citizens, as well as our duties as engineers.

Engineers, whether civil or metallurgical, mechanical or chemical, are specialists. All engineers follow the art and science by which the properties of matter and the sources of power in nature are made useful to man. The whole of recorded history bears eloquent witness to the lofty place which engineers have carved out for their profession in thus ministering to the needs of their fellow men.

They have done this as specialists. But in so doing—in realizing the energies of man to be used in many channels—they have also made it possible for the engineer himself to direct some of his energies to other endeavors if he so desires. In other words, the engineer also benefits from the conveniences and time-saving devices he has brought to mankind. Why then should he alone decline to use some of that time for other worthy purposes—purposes such as making certain that the community in which he lives, works, plays and rears his family is good and progressive?

The engineer as a specialist

In the field with which I am most familiar, that of municipal and local government, the contribution of the engineer as a specialist to the public good is inestimable. In St. Louis today, engineers are working in the planning of new, and the operation of old hospitals, steam and power plants, streets and highways, incinerators, health clinics, penal institutions, park developments, flood control, water pumping systems, street lighting, and a myriad of other functions needed to keep a big city alive.

But I have been dealing with the engineer as a specialist—as the one who draws the plans, makes the studies, and sees to it that the work is completed in accordance with sound engineering practice. Harmonious coordination of all such specialists can alone produce the symphony of the general welfare.

Where then do the other responsibilities of the engineer lie in public life? He has a unique status, with duties even beyond those of the ordinary citizen. His unique obligation lies in the fact that by temperament, by training, by education, by experience—by all the standards of measurement available—he can be an extremely good citizen.

Let us look at the field of civic endeavor—just as an example.

The engineer has objectivity; he must be objective to be a successful engineer. He is careful—given to cautious and thorough analysis of all sides of a problem before he makes a decision. He is judicious—not subject to purely emotional appeals or to the razzle-dazzle of insincere propaganda. He is studious—realizing that action without adequate knowledge is both foolish and dangerous. Where could a better man be found for a civic leader?

The engineer as a citizen

The engineer has all the earmarks of effective, responsible citizenship—except one. In too many instances he lacks the dynamic conviction of his own importance and value as a citizen. He thus adheres too closely to his own specialty, and in greater or lesser degree neglects his duties as a citizen. The results of such apathy for any group are always bad. For the engineer with his unique status, they are worse.

Perhaps the fact is that the engineer is too proud as a professional man to come down into the arena of civic scrubbing and activity, or the actual market place of public affairs. This sort of pride, if pride it be, must give way to practical common sense. The engineer must, both to protect his own professional interests and to play his proper role in promoting the general welfare, cast off his mantle of reticence. He must become more active in civic groups of all kinds—neighborhood associations, improvement groups, local, state—and yes, even national groups. Being more active means being more vocal.

Engineers are clear and logical. They must become persuasive. We have a wealth of talent to be made available for the solution of civic problems, but we must cease hiding that wealth under a bushel. We must learn how to sell what we surely can build. Work with civic endeavors and enterprises is just one of the many areas in which the engineer is not only essential, but wanted.

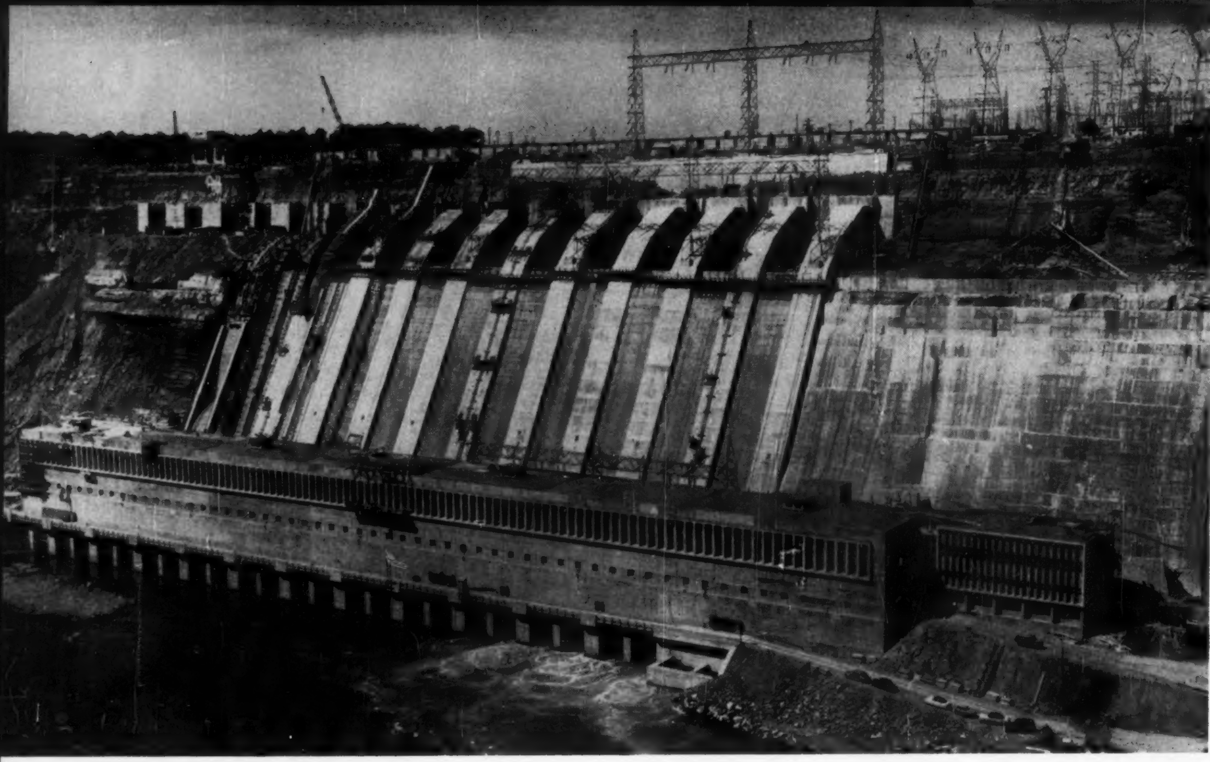
Why not politics too?

Without going into great detail, I firmly believe another area is in the field of politics itself. More engineers should become interested and active in the affairs of one political party or another. They should use their unique abilities and training to further assist the two-party system as developed in America. The better any political organization is—and I am sure that any political organization would be better with more clear-thinking engineers in it—the better will be its campaigns and the better will be the laws of our land.

I have always felt that it is most unfair for citizens, including engineers, to stand idly on the sidelines in so far as political activity is concerned, and then to complain when the results are not entirely to their liking. If there are big corrupt political machines which have mastered and practiced the technique of controlling voters and legislators for selfish objectives, this is only the result of indifference, apathy, or cowardice on the part of the citizenry.

Bad politics, bosses, and machines cannot be fought from afar. No one has ever succeeded in breaking through a wall of political chicanery and corruption by simply standing far back with clean, white, silk gloves on his hands and a clothespin on his nose. Only organized and honest political effort by good citizens, with courage, skill and vision, has ever succeeded in bringing about political reform. No good can be accomplished, in any field, by cynical inactivity.

(This article has been prepared from Mayor Tucker's address of welcome to members attending the ASCE St. Louis Convention.)



Canadian power development

Planning for Canada's Sir Adam Beck–Niagara Generating Station No. 2 commenced many years ago, but active construction did not start until October 1950, after the ratification of the Niagara Treaty of 1950 with the United States. The first generating unit in this development on the Niagara River, near Queenston, Ontario, was put in service on April 26, 1954, and the twelfth and last unit in the initial and major development, on August 8, 1955. The remaining part consists of a pumped storage generating station, now under construction, and four units in the main generating station similar to those already operating. These four units, for which the headworks have been built, will be added as load demands and other factors dictate.

This Sir Adam Beck–Niagara Generating Station No. 2 consists of six principal parts, indicated by letters in Fig. 1 as follows: (**A**) two separate intakes of the Johnson-Wahlman type on the shore of the Niagara River, about a quarter mile downstream from Chippawa, Ontario; (**B**) two parallel concrete-lined tunnels about $5^1/_2$ miles long and 45 ft in finished diameter; (**C**) an open canal 200 ft wide and $2^1/_4$ miles long; (**D**) a forebay with headworks at the top of the gorge above the powerhouse; (**E**) 12 concrete-encased steel penstocks 19 ft in diameter; and (**F**) a powerhouse containing 12 generating units, each consisting of a turbine with a rated capacity of 105,000 hp, directly connected to an 80,500-kva generator.

In addition, remedial works in the Niagara River, closely related to this development and to the projected development in New York State, are now under construction.

Development of power from the Niagara River on a large scale commenced soon after 1890 on the New York side of the river. This was followed early in the present century by the construction of three plants in Ontario and the extension of the developments on the United States side of the river. The increasing amounts of water being withdrawn from the river for power production and for other projects on the Great Lakes focused attention on the possible effect on the scenic spectacle and indicated the necessity for international control measures. The International Waterways Commission was appointed in 1902 and, following its comprehensive reports, the Boundary Waters Treaty of 1909 was signed and ratified. This treaty, among other items, set a limit on the amount of water permitted to be withdrawn from the Niagara River for power production.

By 1923, facilities to use all (and more than all) the permissible amount of water had been installed, but the limitations were rigidly applied until World War II created an emergency warranting temporary increases so that all existing generating facilities could be fully utilized. To permit these additional wartime diversions to be made without adverse effects on water levels and scenic values, between 1943 and 1946 a remedial weir was built in the Chippawa-Grass Island Pool, the comparatively tranquil part of the river above the Upper Rapids.

OTTO HOLDEN, M. ASCE, Chief Engr.
The Hydro-Electric Power Commission of Ont.
Toronto, Canada

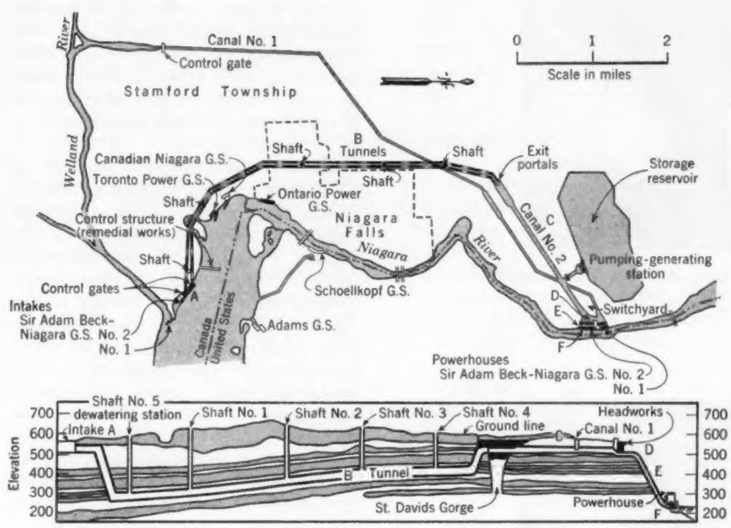


FIG. 1. Canada's Sir Adam Beck–Niagara Generating Station No. 2 will be capable of developing 1,680,000 hp from Niagara River at the Falls with water made available to Canada by Treaty of 1950. A pumped storage generating station, a feature of this development still under construction, will be capable of developing 276,000 hp of primary energy during daylight, high-demand periods from surplus water pumped to storage during night hours. New powerhouse for No. 2 development, with control room at right, is seen on facing page. Old No. 1 powerhouse is out of photo at right.

at Niagara Falls nears completion

After the conclusion of the war, the urgent demands for additional power, implemented by observations and studies made in the seven years 1943–1950, paved the way for agreement among authorities in both countries leading to the Niagara Treaty of 1950, which was very largely a revision of certain clauses of the Boundary Waters Treaty of 1909. However, the new treaty approached the problem from a different angle. It made paramount the maintenance of scenic values, placed power diversions in second place, and provided for further investigation and the construction of remedial works. Maintenance of scenic values was assured by fixing a minimum flow that must pass over the Falls. Only the remaining flow after that requirement is met may be diverted for the generation of power. For a mean flow in the river, this power diversion will be in excess of that permitted by the Treaty of 1909 plus the temporary wartime diversions.

Ratification of the treaty enabled a start to be made on new generating facilities, the first of which is the Sir Adam Beck–Niagara Generating Station No. 2, here described. As the wartime diversions were of a temporary nature, no new plants to use them would have been warranted, and furthermore new construction for that purpose was prohibited by the terms of the international correspondence which arranged for the temporary diversions. [Proposed plans for developing the United States portion of the flow of the Niagara River were given in an article by Ivan Sattem and C. G. Belousow, in CIVIL ENGINEERING for April 1952, but construction has not yet started.]

Economic features

At mean levels there is a total fall in the Niagara River from Lake Erie to Lake Ontario of 326 ft. Of this, 225 ft occurs at the Falls and in the rapids extending for about a mile above them. A further 90 ft of fall occurs in that part of the river from the base of the Falls to Queenston. Early developments made use only of the drop close to the Falls, neglecting entirely the potential in the lower river. When the Queenston Development (now the Sir Adam Beck–Niagara Generating Station No. 1) was projected in 1917, all the available fall that could be economically developed was utilized. Thus the output of this plant is 29.7 horsepower per cu ft per sec (hp per cfs) whereas the Ontario and Toronto power plants close to the Falls generate respectively 17.4 and 9.5 hp per cfs of water used. To utilize the higher head, an open canal over 12 miles in length was excavated extending from Chippawa to the crest of the gorge above Queenston. For some 4 miles this canal follows the Welland River, deepened and widened; the next mile is in an earth cut; and the remainder is a concrete-lined rock cut with a maximum depth, including that in the earth overburden of 140 ft.

The new development, the Sir Adam Beck Niagara Generating Station No. 2, adheres to the same fundamental idea of utilizing as much of the available head as is economic but takes cognizance of the immense de-

Twin power tunnels are concrete lined, 5½ miles long, and 45 ft in finished diameter. Each has capacity of 20,000 cfs.

Unlined section of power canal (C in Fig. 1) is 200 ft wide and 2¼ miles long. It receives flow of both tunnels.

New power canal to Generating Station No. 2 crosses old canal to Generating Station No. 1 at grade. Canal and gate structure at left lead to pump-generating station shown in Fig. 1.

velopment of the area in the thirty years since the No. 1 development was built. It was considered inadvisable to impose the additional interference to free movement of surface traffic that would result from the construction of one or more open canals in the area, and to meet changed conditions, and after careful study of costs, tunnels were chosen as more suitable.

Another advantage of tunnels is that their course is more direct—about four miles shorter than the canal of the No. 1 development. The intakes from the Niagara River (**A** in Fig. 1) are located a short distance downstream from the intake of the No. 1 plant, and the powerhouse is close to the upstream end of the No. 1 powerhouse. The gross head from intake to lower river is thus almost the same for both developments—315 ft.

The initial layout provided for one intake, one tunnel with a capacity of 20,000 cfs, and provision for a second tunnel and power works for seven 75,000-kw units. Work proceeded on this initial stage until the summer of 1952, when continued growth in power demands and other factors dictated extension of the project. Authorization was given for the construction of a second tunnel and appurtenant works and for five additional 75,000-kw generating units.

Intakes designed to exclude ice

Immense quantities of ice are carried by the Niagara River following certain conditions of temperature and wind. Some of the ice jams have been spectacular and have caused great property damage. Several power plants frequently suffer reduction in output because of ice. Therefore the intakes for the new plant (**A** in Fig. 1) are designed to withdraw large quantities of water from the river while excluding ice.

When the No. 1 plant was built some thirty years ago, an original design for a gathering-tube type of intake was developed by R. D. Johnson and Petrus Wahlman, M. ASCE. It was subject to rational mathematical analysis, and a model was built which confirmed the theory. Experience over the first few years of operation, however, showed that, at the location of the No. 1 intake, a more conventional curtain-wall type of intake would function satisfactorily. Provision however was made in the design for the addition of gathering tubes if necessary.

Since the No. 2 intake would be called upon to divert much larger quantities of water from the river, it

was logical that consideration should be given to the Johnson-Wahlman gathering-tube type. A model of the intake and the adjacent part of the river was built on a large, undistorted scale, in the river-flow laboratory at the University of Toronto, and in this model details of design were worked out.

Separate intakes are provided for each tunnel. These consist in each case of a concrete tube 500 ft in length, located on and parallel to the shore of the Niagara River. The tube is square in section with inside dimensions of 23 × 23 ft at the upper end, flaring until the full section of 45 × 45 ft is attained. Water enters the tube through slots in the vertical riverward face. These slots vary in height from 13.33 to 7.5 ft for intake No. 1, and 17 to 6.1 ft for intake No. 2. The top of the slots in each case is 6 to 8 ft below minimum river level. The slots are separated by piers, each with its axis inclined to the face of the intake at an angle to guide the water into the tube with the least possible loss. The dimensions of the slots and the angle of inclination of the piers are so designed that the draft per foot of length is constant as nearly as possible.

The efficiency of these intakes was tested in March 1955, when an almost unprecedented flow of ice out of Lake Erie formed an enormous ice jam in the lower river. Under the adverse conditions which also existed in the upper river at that time, the intakes functioned most effectively in excluding ice from the water flowing to the tunnels.

Twin tunnels carry 20,000 cfs each

Immediately downstream from the intakes the tubes, 45 ft square, are deflected shoreward through an angle of about 30 deg, and the control works are located at the end of this curve. These works consist of steel gates (one for each tunnel) which make it possible to shut off the flow through the tunnels (**B** in Fig. 1) if necessary. The gates are 58 ft in height by 45 ft in clear width. A transition from square to circular section follows, and then the flow enters a covered conduit 370 ft long and 45 ft in diameter, the same diameter as the tunnels throughout their length. Beyond the covered conduit the profile turns downward at an angle of 30 deg until it reaches a point approximately 300 ft below the ground surface and 280 ft below the water surface in the river. The profile then continues on a slightly falling grade to shaft No. 5, reaching a maximum depth of 330 ft. Thence it rises gradually for nearly 5 miles until the outlet portal is approached. The profile rises at an angle of 30 deg to reach the portal, which is approximately at water level in the canal.

Subsurface geology, thoroughly explored throughout the length of the tunnels, showed conformable rock strata with a slight dip toward the south. The tunnel horizon selected avoided the problems associated with porous, water-bearing and gas-bearing rocks. About 200 ft below the ground surface, in the neighborhood of the intake, there is a layer of dense, impervious Rochester shale 50 to 60 ft thick, and immediately below this is Irondequoit limestone which forms a competent tunnel roof. These strata continue from the intake to the St. David's Gorge, and thus determined the location of the tunnel excavation, which followed five parallel strata of good quality consisting, in order, of dolomite, limestone, a thin layer of shale, and Thorold and Grimsby sandstones.

Excavation was carried out from five shafts located between the tunnels, which are about 250 ft apart. From each shaft a crosscut was driven to each tunnel, and a heading was driven each way from the end of each crosscut until it met the heading from the next shaft. Bench excavation and lining followed. The excavated cross-section was 51 ft in diameter, the lining 3 ft thick, and the finished section circular and 45 ft in diameter. As the excavation progressed, steel arches were installed at 4-ft intervals to support steel lagging, which was removed before concrete was poured in the arch.

Concrete for the lining was supplied from two central mixing plants and dropped from the ground surface through 10-in., steel-cased holes to each tunnel as required. The lining was first placed in the invert for 60 deg of the circumference and finished with steel trowels. The sides and arch were then poured behind steel forms. Each section of the forms was 50 to 90 ft in length and remained in place until the concrete had set, when it was moved forward for the next pour. To secure good hydraulic conditions, extreme care was taken in aligning the forms, thus eliminating roughness at the junction of successive sections. Where irregularities did occur, they were carefully trimmed. Similar care was taken to maintain a smooth joining at the junctions of sides and invert. An extremely smooth surface was secured on the surface for the whole length of each section of the forms.

Excavation and placing of lining were divided into five sections, and contracts for the work were awarded for two sections in tunnel No. 1 to the Rayner-Atlas Construction Co. and for three sections to Perini-Walsh and Associates. The same contractors carried out the work in tunnel No. 2. Construction of the tunnels involved the excavation of 4,500,000 cu yd of rock and the placing of over 1,250,000 cu yd of concrete. [Tunnel construction methods and equipment are given in more detail in two articles by Jesse R. Glaeser, Vice President and Chief Engineer, B. Perini & Sons, Inc., in CIVIL ENGINEERING for October and November 1953.]

From intake to outlet portal, the tunnels are inverted siphons with the lowest point at shaft No. 5, that nearest the intake. At this shaft a dewatering station has been built in the crosscut between the tunnels so that they can be drained for inspection or repairs. The pumping station contains eight submersible-type, four-stage pumps each directly connected to a totally enclosed, oil-filled submersible motor of 450-hp capacity, supplied with power by marine-type cables from controls at ground level. The station is so designed that even if it is entirely flooded the pumps can operate. Each pump has a rated capacity of 4,000 gpm against a head of 340 ft. The pumps draw water from a header connected to both tunnels and will be capable of draining either tunnel in less than seven days.

Canal 200 ft wide

As the tunnels approach the outlet portal, they rise at an angle of 30 deg and converge to discharge their flow into the open canal (**C** in Fig. 1) leading to the forebay. The portals are at the southerly side of St. David's gorge, a prehistoric river channel filled with drift and debris to a great depth. Some 35 years ago this gorge was filled with spoil excavated from canal No. 1. The gorge crossing for canal No. 2 is similar to that used for canal No. 1.

The section of canal crossing the gorge is 2,200 ft in length, trapezoidal in section, with a bottom width of 94 ft and side slopes of two horizontal to one vertical. The bed and slopes of the excavation were paved with a layer of crushed rock on which was placed a heavy concrete lining extending several feet above the normal operating water level. Provision is made for drainage into the canal of water in the rockfill, through suitably designed ports in the lining, should the water level in the canal be drawn down rapidly.

After passing through a transition from the trapezoidal section, the canal enters a rectangular rock cut extend-

ing from the north side of the old gorge to the forebay. This part of the canal is roughly 200 ft wide with close-drilled sides. It is unlined.

A smooth bed was secured by following the natural cleavage planes of the rock strata, which are nearly horizontal. Gradual changes in width and depth are made as necessary to maintain a constant cross-section while conforming to the natural southerly dip of the strata. For the sides also satisfactory results were secured by means of a drilling pattern carefully worked out by the Commission's Construction Division. Very little overbreak occurred beyond the drilling line, and the general alignment of the sides is excellent. The total length of the open canal, including the trapezoidal section, is $2^1/_4$ miles.

As the canal approaches the forebay, it is necessary for it to cross canal No. 1. The plan selected from a variety of proposals to effect the crossing forms an interesting feature of the project. Details of the design were worked out in a model of the adjacent portions of the two canals. Water in the old canal flows at a velocity of 14 fps as compared with 7 fps in the new. To bring these two streams together without shock loss, the channel of the old canal was widened in a transition as it approached the crossover so that the two streams would come together at the same velocity. By offsetting the center line of the new canal beyond the crossover 45 ft from its upstream alignment, the flow from the old canal is diverted into the new, and part of that coming down the new canal is diverted smoothly into the downstream part of the old canal while the remainder passes into the downstream part of the new canal.

In Sir Adam Beck-Niagara Generating Station No. 2, the twelfth of 16 turbines, rated at 105,000 hp each, went into service in August 1955.

The flow in this downstream part of the new canal is greater, and that in the old canal less, than upstream. This increased flow in the new canal is accommodated by widening the channel to 225 ft and thence gradually to 280 ft in the next 1,900 ft of length. At full flow the velocity is 8 fps and the depth 28 ft.

Forebay and headworks

As the canal emerges into the forebay, further widening takes place and the velocity is gradually reduced until at the headworks (**D** in Fig. 1) it is about 3 fps. Before the headworks are reached, an interconnecting canal between the forebays leads off to the left. This is 100 ft wide and 700 ft long.

An interesting feature of its construction was the method used to blast the final plug of rock left until all other work was completed in the new forebay. Throughout the period of construction of the new plant, plant No. 1 was maintained in full service. The final plug of rock left in the interconnecting canal was blasted out behind a compressed air curtain so as not to damage existing structures. From perforations in compressed-air piping laid on the bed of the old forebay in front of the plug, a screen of air bubbles rose through the water, effectively preventing the transmission of shock waves from the blast through the water to the screenhouse of plant No. 1.

The model of the canal built to study and design the crossing of the two canals was also used to study the behavior of the flowing water in the forebay. A very considerable saving of rock excavation resulted from the study of model tests.

The headworks structure is 875 ft long and is equipped with racks of conventional design, checks for emergency gates and motor-operated steel gates, two for each penstock. These latter can be closed by remote control from the powerhouse in case of emergency. Unlike the No. 1 development, there are no valves at the downstream ends of the penstocks; the headgates and emergency gates are the only controls provided.

The headworks superstructure consists only of that necessary to house the operating machinery for the headgates. Equipment includes a 25-ton traveling gantry crane to handle racks, emergency gates, and other equipment.

Twelve welded penstocks

Twelve penstocks (**E** in Fig. 1) have been installed, one for each unit, with provision for four more when the last four generating units are installed. The penstocks are 19 ft in diameter and about 500 ft long, of welded construction with a plate thickness varying from 5/8 in. at the top to $1^1/_2$ in. at the lower end. The penstocks are laid in shallow trenches cut in the face of the cliff, on a slope of 60 deg from the horizontal for the greater part of their length. They are encased in concrete throughout.

Powerhouse for 16 units

The generating station (**F** in Fig. 1) is on the river bank in the gorge a few hundred feet upstream from the No. 1 powerhouse. In many particulars, it exemplifies the progress that has taken place since the earlier development was built. The building itself is an impressive structure of pleasing architectural design, at present 930 ft long to house 12 generating units. Later it will be extended to 1,151 ft to accommodate four additional units. It is 63 ft wide, 50 ft high, and of rigid-frame construction with reinforced concrete walls and roof.

The twelve turbines, built by the Dominion Engineering Works of Lachine, Quebec, have a rated capacity of 105,000 hp each under a head of 292 ft, and rotate at 150 rpm. They are equipped with Woodward actuator-type governors, a single cabinet housing the governors for two adjacent units. The turbines are spaced 55 ft center to center and are directly connected to vertical-shaft generators.

Tests completed on four turbine units show high efficiencies. A maximum efficiency of between 93 and 94 percent was attained on three of these, and that of 94.7 percent on the fourth, which was of a slightly modified design. All showed a maximum output slightly over 112,000 hp at rated head with high efficiency extending over a wide range of their capacity.

The generators, of which six were built by the Canadian General Electric Company and six by the Canadian Westinghouse Company, are rated at 80,500 kva 95 percent power factor, three phase, 60 cycle, 13.8 kv. They are totally enclosed, air-circulation-water cooled, with non-continuous

(*Continued on page 98*)

Sixth article in a series sponsored by ASCE Hydraulics Division's Committee on Research

LARGE-SCALE FLUME

at Waterways Experiment Station

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A large flume is a versatile item of equipment that has been used to excellent advantage in a variety of hydraulic investigations at the Waterways Experiment Station of the Corps of Engineers at Vicksburg, Miss. The flume (Photo 1) is approximately 600 ft long, 125 ft wide, and 2.5 to 3 ft deep. The maximum discharge of the water-supply system is about 100 cfs. Inflows are controlled by a 36-in. electrically operated gate valve, and are measured by two pitometer rod meters inserted in the 36-in. supply line. Water-surface elevations at the exit are controlled by four electrically operated tailgates extending across the lower end of the flume. A 100-ft rolling catwalk, mounted on rails, spans the flume to provide a working and observation platform.

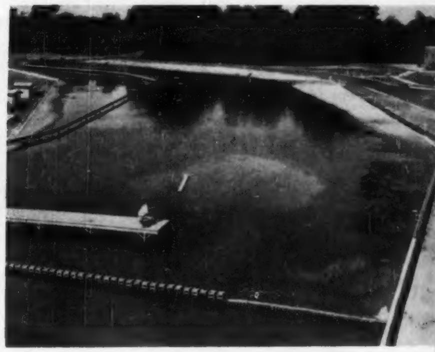
The flume is filled with medium-fine natural sand having a specific gravity of about 2.6 and a mean grain diameter of about 0.2 mm. This bed material can be molded to any desired channel and bank configuration by means of vertically-sliding graduated rods suspended from a graded rail attached to the mobile catwalk. These same rods are also used for sounding operations to determine channel configurations during and after tests.

This apparatus was originally designed and used for an undistorted, movable-bed model study of a typical bendway of the Mississippi River, to a scale of 1:60. The purpose of this study was to investigate the behavior and effectiveness of different types of bank revetments, to develop improved revetment designs and practices, and to develop and test other possible methods of preventing or controlling the meandering of the Mississippi River. Such a study required a model with both the channel and the banks of erodible material, and a linear scale sufficiently large to permit reproduction of such features as articulated revetment as nearly as practicable to scales of weight and strength as well as dimensions.

Cut-and-try adjustments of the model discharge scales, bed-load feed, and time and slope scales were made to arrive at proper model-prototype relationships required for accurate reproduction of the bank erosion, bar building, and channel changes recorded in the corresponding reach of the Mississippi River. Thereafter the model was used to determine the results to be expected in the river from various proposed revetments, spur dikes, dredged cuts, and other regulative measures. Almost any bend of the river can be modeled in this flume, by making the model a "mirror-image" of the prototype if required by the direction of curvature of the flume.

Full-scale tests of articulated revetment placed on Mississippi River sand were carried out in a smaller flume constructed within the headbay of the large flume and subjected to velocities encountered in the river. This test section (Photo 2) is 20 ft long and 5 ft wide and contains an 18-ft length of glass panel for observation purposes. Another smaller flume, constructed in the large flume to take advantage of the large discharge available, has also been used for testing the hydraulic performance of a 1:10-scale model of a large Tainter gate as shown in Photo 3.

Further use has been made of the large flume for modeling the Old River low-sill control structure, which will regulate flows diverted from the Mississippi River into the Atchafalaya River in the vicinity of Old River, Louisiana. This model, Photo 4, required a discharge of about 75 cfs and was used to investigate the over-all performance of the structure, including flow conditions at abutments, stilling basin action, and gate-operating forces.



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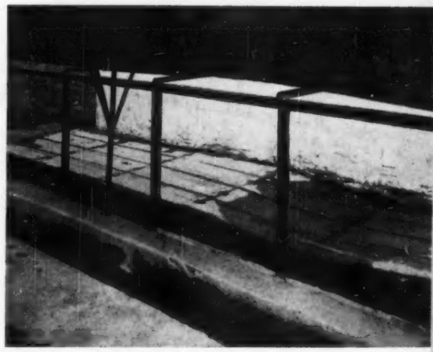

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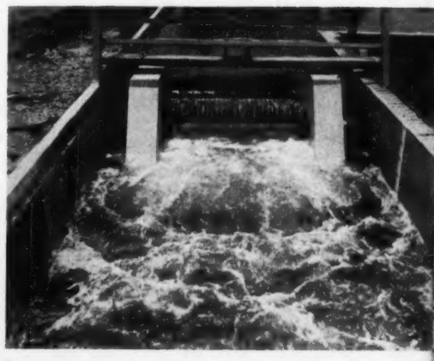

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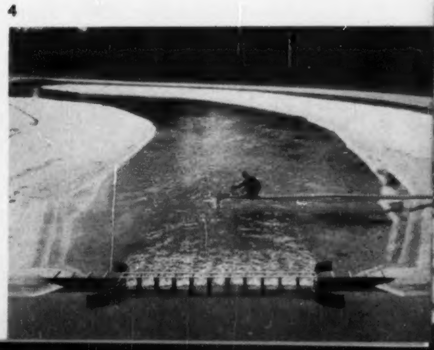
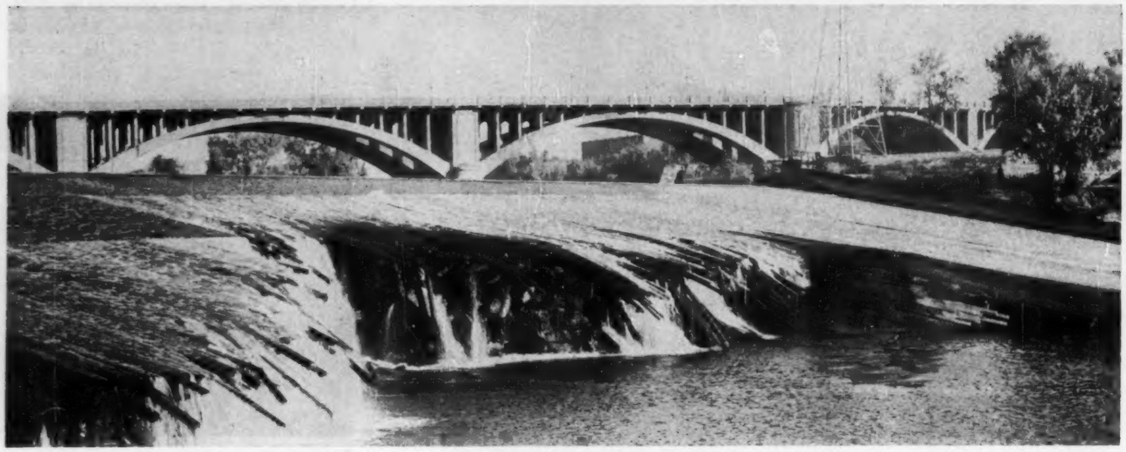




Chute spillway preserves St. Anthony Falls

ARTHUR V. DIENHART, A.M. ASCE, Hydraulic Engineer,

Historic St. Anthony Falls on the Mississippi River at Minneapolis is the scene of several million-dollar construction projects, in progress or recently completed (Fig. 1). These include the Lower Lock and Dam, under construction by the Army Corps of Engineers (Civil Engineering, August 1954); bridge reconstruction by the City of Minneapolis; and hydro-plant, submarine-cable, and spillway construction by the Northern States Power Company (NSP) and subsidiaries.

The spillway work, recently completed, marks the end of the era of timber construction at the falls. A reinforced-concrete chute has replaced a plank apron, supported on rock-filled timber cribs, which served since 1870 to protect the falls from erosion (Fig. 2).

In prehistoric times, the falls were situated near the confluence of the Mississippi and Minnesota Rivers, about eight miles downstream from their present location. The Mississippi, as it cascaded over the scarp of the Platteville limestone ledge forming the river bed, washed away the underlying soft St. Peter sandstone, thus undermining the limestone ledge. As the natural support for the ledge was removed, large chunks of it fell into the gorge, causing the scarp to recede upstream. The average rate of recession, in historic times, has been estimated at 4.8 ft per year between 1680 and 1766, and at 6.7 ft per year between 1766 and 1870, when the timber apron was constructed. In its present condition, the limestone ledge is about 12 ft thick at the scarp, tapering to less than a foot thick at its upstream edge about a quarter-mile away. If the recession of the scarp had been allowed to continue unchecked, the erosion of the sandstone would have destroyed the remaining quarter-mile-long limestone ledge, and St. Anthony Falls would have ceased to exist.

The 1870 apron and other remedial structures in the St. Anthony Falls area originally were built by the Federal Government. From 1870 to 1884, Congress appropriated over $600,000 for work at the falls, and Minneapolis citizens and businesses contributed more than $300,000.

The timber apron and adjacent timber dams and sluices required almost continuous maintenance and alterations. Congress refused to appropriate federal funds after 1884, so in 1888, present NSP subsidiaries, which operated water-power canal systems adjacent to the Government's installations, assumed responsibility for the continued maintenance of the federal structures. From 1888 through 1953, over $600,000 in private funds were expended in protecting St. Anthony Falls.

Apron damaged

The record flood of April 1952 poured 75,000 cfs over the falls and damaged the historic timber apron structure beyond repair. Prompt rehabilitation of the apron was essential to prevent erosion of the sandstone, which would cause further recession of the scarp. NSP engineers studied various designs, aided by model studies at the University of Minnesota's St. Anthony Falls Hydraulic Laboratory, located adjacent to the apron. The St. Paul District Engineer, U.S. Army, was consulted throughout the study because of the Corps' navigation interest.

At the outset, it was determined that concrete and steel would be used for the replacement structure, to avoid the heavy maintenance costs required by a timber apron. Construction of a chute-type spillway (Fig. 3) at the location of the old apron had four main advantages: (1) It made use of the existing concrete crest; (2) it did not disturb adjacent installations; (3) it provided adequate protection for the scarp and the underlying sandstone; and (4) it could be

Floods of 1952 washed out parts of 82-year-old timber apron (far left) which prevented undercutting of limestone ledge and hence further retreat of St. Anthony Falls upstream. Ledge broke off as underlying soft sandstone was worn away. In photo at left, new reinforced concrete spillway, or apron, handles 25,000 cfs successfully in 1955. Theoretical maximum capacity is 100,000 cfs.

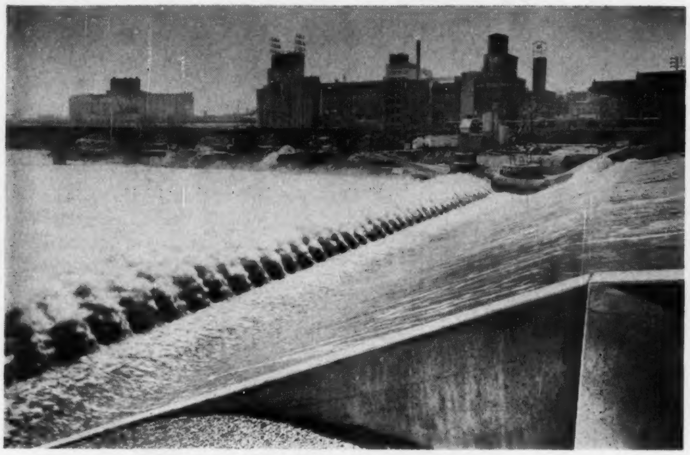
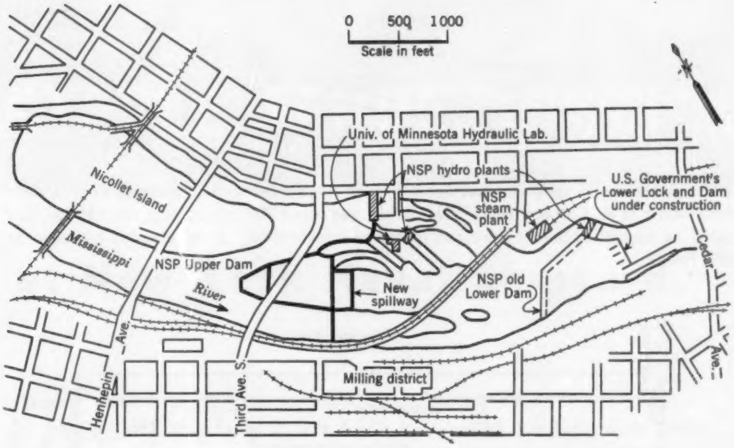


FIG. 1 (Below). At St. Anthony Falls on Mississippi at Minneapolis, Minn., new spillway and adjoining hydro plants are construction projects recently completed by Northern States Power Co. (NSP) and subsidiaries.



Northern States Power Company
Minneapolis, Minn.

built without resort to downstream cofferdams. In the interest of economy, no stilling basin was built. The chute discharges approximately at the elevation of the lower pool, which is controlled within narrow limits by downstream structures. To facilitate construction of the lower portions of the new spillway, this lower pool was drawn down from its normal level at El. 750 mean sea level to El. 746 msl. Sill blocks were provided at the lower end of the chute after model studies indicated they would move the erosive effect on the river-bed downstream far enough to prevent undercutting of the row of rock-filled, sheetpile cells which provide the downstream anchor for the spillway pavement. The need for future intermittent maintenance of the riprap adjacent to the cells was recognized and was considered less costly than the construction of a more elaborate spillway.

The easily erodible nature of the poorly cemented St. Peter sandstone required that all exposed faces be protected by graded filters to prevent movement of the sandstone beneath the new structures. A three-layer filter was used, the sandstone being covered with coarse sand, which was covered in turn with fine gravel, followed by coarse gravel.

In air view of St. Anthony Falls area, new reinforced concrete chute spillway appears near center, between arched viaduct of Great Northern Railroad in foreground and Third Avenue Bridge above. Lower Lock and Dam built by Corps of Engineers are out of photo below.

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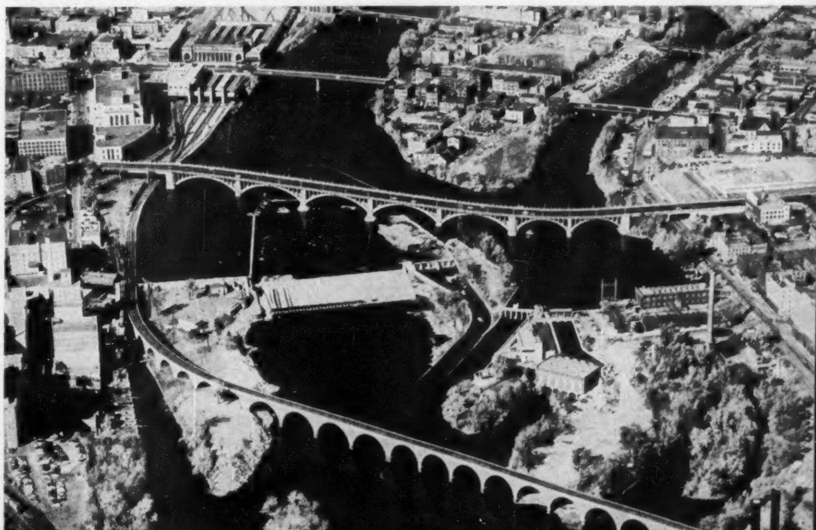


Early designs provided sluiced-rock fill for the space between the coarse-gravel filter and the bottom of the apron pavement. However, delays encountered in removing the old timber substructure and in clearing limestone tumble-rock from the river bed made it necessary to place the fill in cold weather. It was decided that the economic advantage of the rock fill was not sufficient to compensate for the difficulties involved in sluicing it in zero weather, so the sand filter was expanded, where necessary, to occupy the equivalent space of the rock fill. Filter material was placed in 9-in. layers and compacted by vibration.

Temperature range of 140 deg

The problem of thermal expansion and contraction of the concrete slab received considerable attention during design. The river flows over the spillway mostly during the spring runoff. For the remainder of the year, the flow usually is diverted to hydroelectric plants and flour mills. Thus the apron is exposed to severe climatic changes with a maximum temperature range of about 140 deg F. The amount of restraint imposed by the underlying fill, the downstream row of cells, and the connection at the existing crest, was difficult to determine.

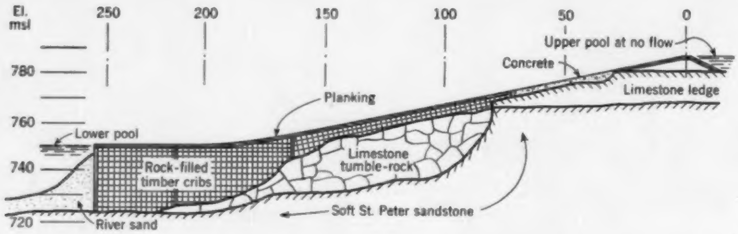


FIG. 2. Timber apron was constructed in 1870 to prevent further undercutting of limestone ledge at St. Anthony Falls. This apron was about 200 ft long from crest to sill, and rested on rock-filled timber cribs and limestone tumble-rock. It was severely damaged by 1952 floods.

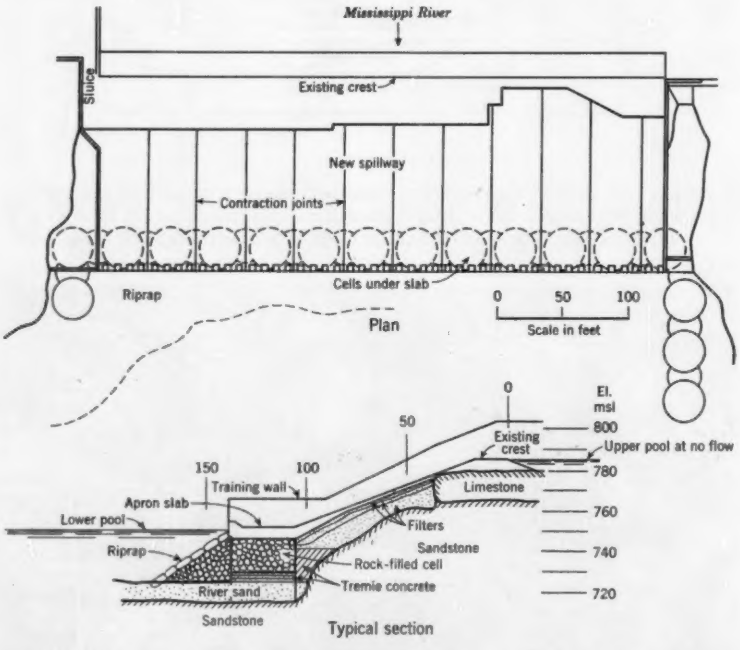


FIG. 3. Reinforced concrete spillway, completed in August 1955, replaces old timber apron shown in Fig. 2. Spillway is about 140 ft long from crest to sill and rests on sand and gravel filters and rock-filled steel cells. Contraction joints have rubber seals.

The final design provided longitudinal contraction joints, with rubber seals and no through reinforcement, at about 37-ft intervals. The new pavement was doweled into the limestone scarp to prevent uplift displacement, but the vertical joint between the new concrete slab and the existing concrete was painted to break bond. Reinforcing steel was carried continuously through the transverse construction joints, and bond was maintained between the concrete surfaces at the construction joints. The area of the new slab therefore was divided into rectangles about 37 ft by 100 to 135 ft, extending continuously from the crest to the toe.

Construction procedures

Construction operations were carried out in the following sequence:

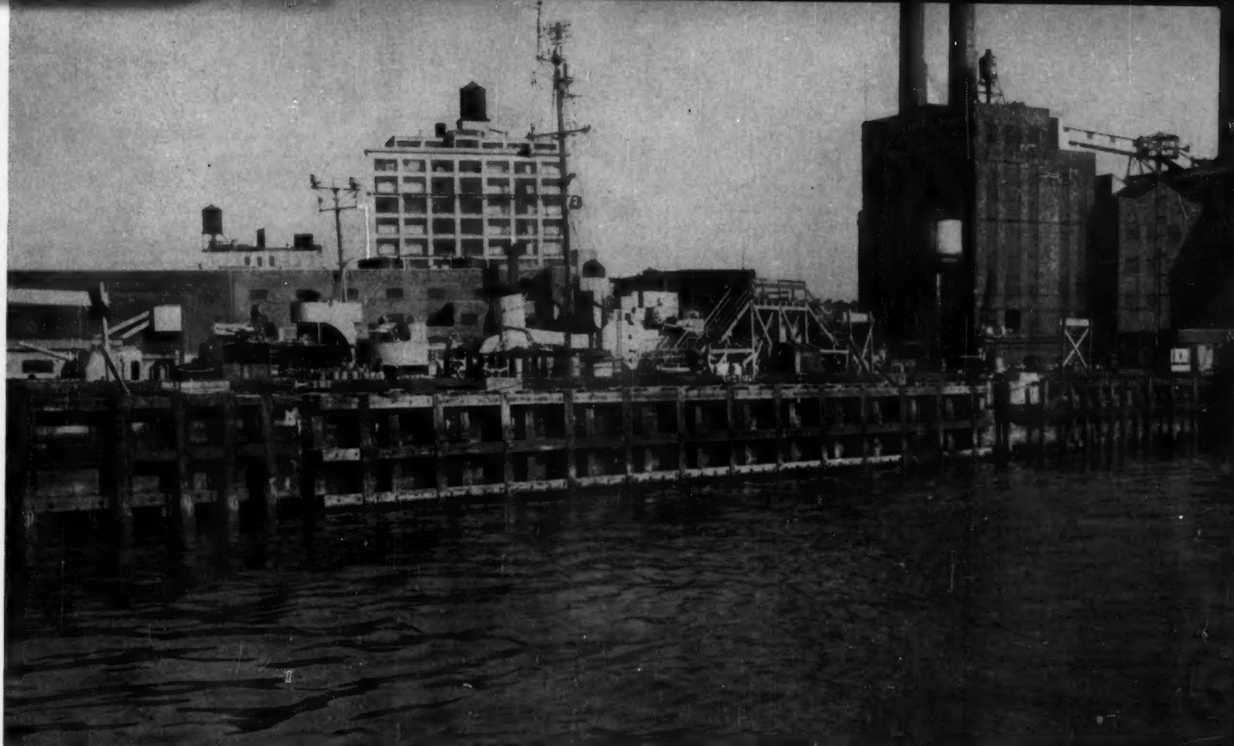
1. A diversion cofferdam was built across the existing crest.
2. The old rock-filled timber-crib apron structure was removed, exposing the sandstone.
3. Thirteen circular, steel sheetpile cells were driven and filled with rock.
4. The sand and gravel filter layers were placed.
5. The concrete cap was placed across the top of the cells.
6. The concrete pavement and training walls were placed on the filter bed.
7. The concrete sill blocks were built.
8. Three training cells were driven on the left bank.
9. Riprap was placed along the toe of the cells.
10. A training cell was driven on the right bank.

Construction began in June 1954 and was carried through Step 9 by January 1955, when work was suspended for the winter. Work on the right-bank cell was begun in June 1955 and completed in August 1955.

The most troublesome feature of the job was the removal of the old timber crib and the limestone tumble-rock, which involved considerable underwater blasting to facilitate the dredging. Most of the tumble-rock had to be removed to permit the cells to be driven.

The spring runoff of 1955 was normal, and the new spillway handled 25,000 cfs satisfactorily, showing a good correspondence with the model performance. The design was based on a theoretical maximum flow of 100,000 cfs.

Foley Brothers, Inc., of St. Paul, was the general contractor. Pioneer Service & Engineering Co. of Chicago prepared detailed designs from conceptions by G. E. Loughland, A.M. ASCE, then Engineering Consultant for NSP. The project cost was about $1,200,000.



RETRACTABLE FENDER SYSTEM

adopted at New York Naval Shipyard

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A retractable fender system for piers based on a new design principle is being installed in the New York Naval Shipyard to replace deteriorated sections of conventional type. The main advantage of the new system is that it distributes the energy of impact to a larger area of pier, affording better cushioning between moored vessel and pier. Other advantages are:

1. Lower initial cost
2. Ease of fabrication and installation
3. Resistance to superior striking force, minimizing breakage of the various fender members
4. Very low maintenance cost
5. Ease of replacement of worn-out sections

The retractable fender consists of vertical contact fenders spaced 8 ft on centers (instead of the piles of the conventional system), bolted to three rows of wales which are fastened to holding posts. The posts are suspended by six bolts of $1^1/_4$-in. diameter in the slotted holes of two U-shaped steel brackets fastened to the bulkhead, as shown in Fig. 1.

When the fender is subjected to a force greater than the resultant of its weight in the direction of the slots and the friction of the bolts, it moves backward and upward for a distance of 3 in. The posts then bear against the back of the brackets, and the wales, after deflecting $^1/_2$ in., come to rest against a vertical bearing-board fastened to the bulkhead. This improved capacity to absorb a larger amount of the energy of impact results from the fact that, when

Photo above:

Trial section of new rectractable-type fender system is seen in place on Pier K at Brooklyn Naval Base. Conventional fender system is still in place on each side.

a fender is pushed back, three posts at each side intermittently follow the movement, thus gradually increasing the resistance to the acting force.

A static pressure test was performed on a trial section of the retractable fender system to determine the force required to move one fender back to its resting position, and to observe the general behavior of the various structural members when subjected to stress. Test pressures were provided by a 50-ton hydraulic jack bearing on a frame fastened to the sea wall and acting on one fender (Fender A) at a point one foot above the middle wale.

At an applied pressure of 50 tons, the top of the fender moved back $2^3/_4$ in., and the bottom fender-supporting wale was observed to be resting on the bearing board. Evaluation of the data and observed test conditions indicated that when 50 tons of applied pressure were required to retract the fender to its farthest position, the six posts participating in the retraction (the three immediately adjoining on each side) transmitted this force to the bulkhead with varying intensity, the outermost pair retracting only $^1/_4$ in. A similar test performed on a pile of the two-row double-wale system revealed that an applied pressure of 18 tons was sufficient to cause a deflection of 1 in. in the two outer wales, thereby inducing a stress of 5,000 psi. This is considered to be the limiting stress to which the wales can be subjected.

These tests indicate that when a pile of a conventional fender system is subjected to pressure, the wales can absorb a maximum energy of

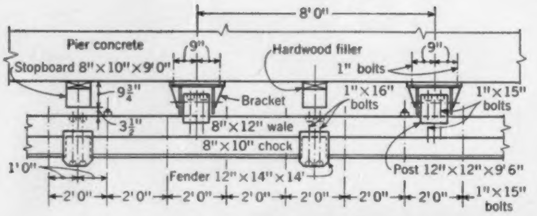
$$\frac{36,000}{2} \times 1 \text{ in.} = 18,000 \text{ in.-lb.}$$

The energy absorbed by the retractable fender system under the same test conditions is

$$\frac{100,000}{2} \times 3 \text{ in.} = 150,000 \text{ in.-lb}$$

or 8 times the energy absorption. It is also important to note that the retractable system is well protected from damage since the residual force of the impact is transmitted directly to the bulkhead.

On most piers, the relieving platform is located 2 or 3 ft above mean low water level, and in the conventional pile fender system the lower wale, to which the pile is fastened, is located from 5 to 6 ft above this level. At low tide, the camels, which are interposed between the moored vessel and the fender system, often strike the unsupported piles with hard blows which break or otherwise damage them. When this occurs, the upper wale, on which the top of the pile is connected, is pulled out and broken by the leverage exerted by the pile bearing on the lower wale. A photograph shows typical damage to a fender system of the conventional type.



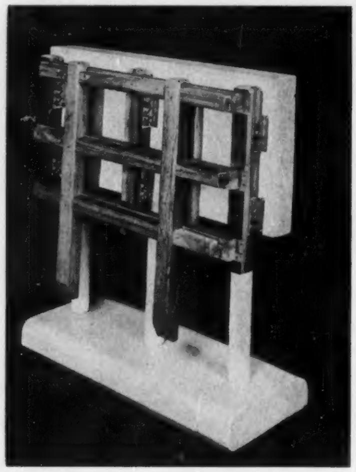


FIG. 1. Model of retractable fender system and labeled cross section show arrangement of wales, fenders, stopboards, and posts. Fender system is hung on posts by means of bolts moving in slotted brackets.

In the retractable system, the posts extending below the relieving platform are fitted with a third wale near mean low water, which gives a valid bearing to the fender stub (Fig. 1). The upper bracket is provided with L-shaped slots to permit the upper part of the fender system, when hit at low level, to move upward and outward. The lower part of the system then moves upward and inward. Guided by the slotted hole of the lower bracket, it bears on the stop board for added resistance.

Construction and maintenance

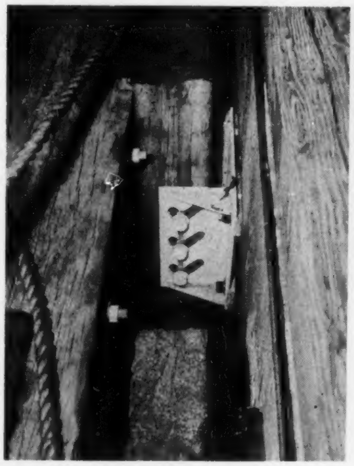
The component members of this new fender can be prefabricated to exact dimensions and treated at the mill, assembled in large sections near the site and lowered in separable units onto the brackets previously installed on the sea wall. This procedure, possible only with this type of fender, eliminates the time often lost as a result of high tides and inclement weather, one of the main factors in the high erection cost of the conventional fender system.

Maintenance of the new system is anticipated to be very inexpensive. In the 22 months since the 104-ft trial section was installed, not a single member has been broken. During that time, besides smaller ships, three large carriers were berthed for long periods against this fender in rough weather, including hurricanes Carol and Edna. The conventional system at the same berth, during the same period, suffered considerable damage.

Replacement of a broken fender or wale in the retractable system is a simple matter, since each wale is the length of a bent, and only the wale itself need be replaced. In the conventional system where the wales have to be of considerable length in order to obtain the proper deflection, and the splices of outer and inner wales alternate at different bents, the removal of a broken wale involves the removal of three or four bents of the system.

An inspection made recently of the suspending bolts and slotted brackets showed negligible wear. It also should be noted that when the posts are in their retracted position, they come to rest against the back of the brackets and

Close-up shows how fender system is hung on bolts moving in slotted brackets attached to each post. Pressure causes bolts in upper brackets (here pictured) to move upward either outward or inward. Lower brackets carry slots permitting movement only upward and inward. See Fig. 1.



Damage to conventional two-stringer fender system is most serious when camel is floating (as shown). Pressure is thus brought to bear on piles a considerable distance below lowest stringer, causing pile movement and breakage of upper stringer.

the bolts cease to be under stress. The function of the bolts is merely to support the weight of the fender system on the brackets. To eliminate corrosion, the steel brackets and bolts were hot-dip galvanized after fabrication.

Comparative costs

Replacement of an 88-ft section of an existing two-row double-wale system with a similar conventional fender system, using greenheart piles and southern pine wales and chocks, would cost about $600 per 8-ft bent, or a total of $6,600. Replacement of the same section of fender with the new retractable three-wale system using red oak, cost $550 per 8-ft bent, or a total of $6,050.

Replacement of one outside top wale of the old system, broken at the point of connection with the pile, necessitates the replacement of a 24-ft wale and the unbolting and refastening of three piles and six chocks. This operation would require a period of two days and a crew of four men, or

Labor, 8 man-days @ $22.00 . . .	$176.00
Material, 6″ × 12″ × 26′ (156 fbm @ $0.20)	31.00
Total	$207.00

To replace the two lower wales of the old system broken at the pile connection requires the removal of the 24-ft rear wale and the 32-ft front wale, unbolting and refastening of four piles and eight chocks. To perform this operation would take four days and a crew of eight men, or

Labor, 32 man-days @ $22	$704.00
Material, 348 fbm @ $0.20	69.60
Total	$703.60

Replacing any one wale in the retractable system requires the removal of one fender and two chocks, which is done in less than one day by a crew of four men or

Labor, 4 man-days @ $22	$ 88.00
Material, one 8″ × 12″ × 8′ (64 fbm) @ $0.20	12.80
Total	$100.80

To replace one 70-ft pile in the old system would require the assembling of pile-driving equipment, the use of a flat railroad car to transport the pile to the site, and the assistance of a crane to handle the pile. A crew of four men would take two days to replace the pile, or

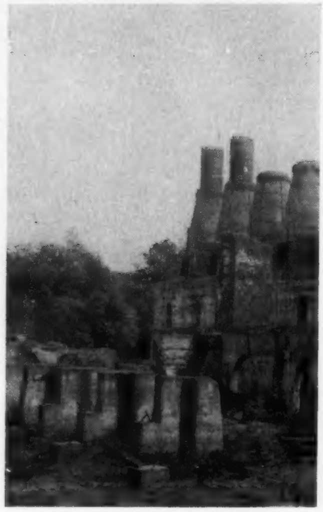
Labor, 8 man-days @ $22	$176.00
Material, one 70-ft greenheart pile .	181.00
Total (not considering equipment needed)	$357.00

To replace a fender in the retractable system, which takes the place of a pile, requires one day and a crew of four men, or

Labor, 4 man-days @ $22	$ 88.00
Material, one 12″ × 14″ × 14′ (196 fbm) @ $0.20	39.20
Total	$127.20

These figures for comparative costs in the New York Naval Shipyard piers more than justify the early adoption of the new system. After observing the behavior of the trial section, the Bureau of Yards and Docks, Department of the Navy, authorized replacement of the worn-out sections of the conventional fender system in several of the New York Naval Shipyard piers with the retractable system. (With the consent of the Navy, a patent on this system has been applied for by Mr. Blancato.)

Cement and concrete of the



C. WITT, M. ASCE, Consulting Engineer, Chicago, Ill.

In each of the past ten years the cement industry has produced more portland cement than the previous year. In 1954, production reached a high of 271 million barrels, and the more than fifty companies manufacturing this material sold over $700,000,000 worth at an average price of $2.67 per barrel of 376 lb. According to the U.S. Bureau of Mines, the industry needs to expand its capacity by at least 10 percent a year for several years to supply the needs of engineering construction. This article is written by an engineer with long experience in portland cement technology—from deposits of raw materials to concrete in place. As a result of his research and experience, Dr. Witt is convinced that improved cement will lead to improved concrete, as has always happened in the past.—Editor.

When portland cement was patented by Joseph Aspdin, a stone mason of Leeds, England, in 1824, there was only one type of kiln—the vertical. On the basis of modern engineering practice, his selection, proportioning, grinding, and heat treatment of raw materials were very crude, but his work initiated one of the world's largest and most important industries.

In today's manufacturing processes, the vertical kiln of Aspdin's time has been replaced by horizontal rotary kilns of steel, which permit continuous operation. The rotary kiln was invented in 1866. Kilns more than 12 ft in diameter and 500 ft long are now in use. Kiln feed contains calcium, silicon, aluminum, and iron. The principal raw materials are limestone and clay or shale. Sometimes, however, sea shell is substituted for limestone, and blast-furnace slag for clay. Considering the great industrial importance of concrete and the billions of barrels of clinker that have been ground into cement, the rotary kiln may be termed one of the world's great inventions.

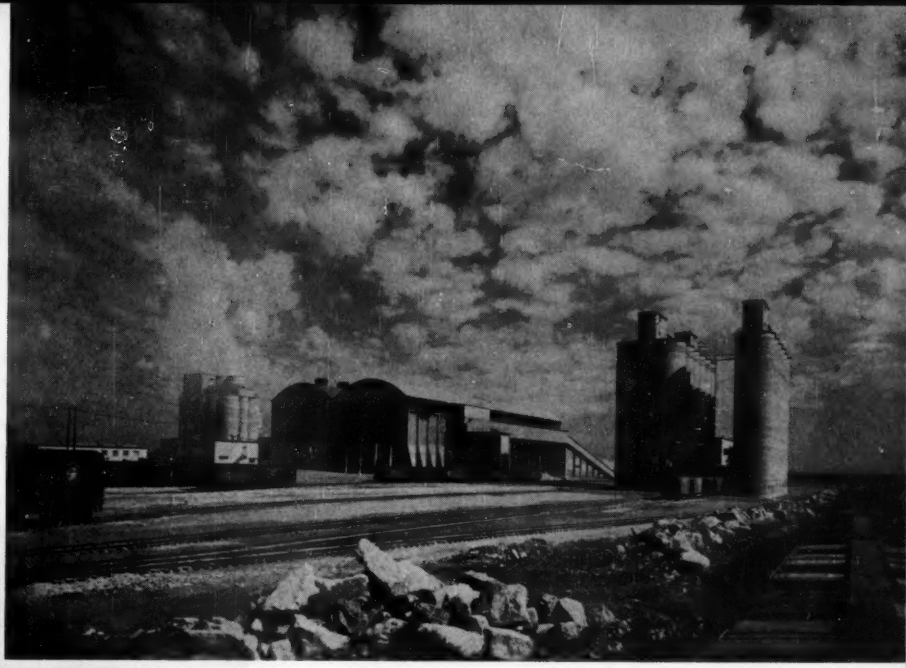
It is now known that clinker consists primarily of four synthetic minerals, the most important of which is tricalcium silicate. This was discovered and reported by Le Chatelier in Paris in 1904. Following him, many researchers have made valuable contributions. Full advantage has not been taken of this information because manufacturers still are unable to prepare each clinker mineral separately from pure oxides, and to proportion them as desired. The extent to which information on clinker composition is improving kiln feed varies from plant to plant. It depends on the nature of the raw materials, the proportioning, the process (wet or dry), the plant equipment, and the extent of the laboratory control. For many years the manufacturing process was largely a matter of trial and error. On the basis of today's much greater knowledge, still far from complete, it is surprising that a usable commodity could have been produced in that way.

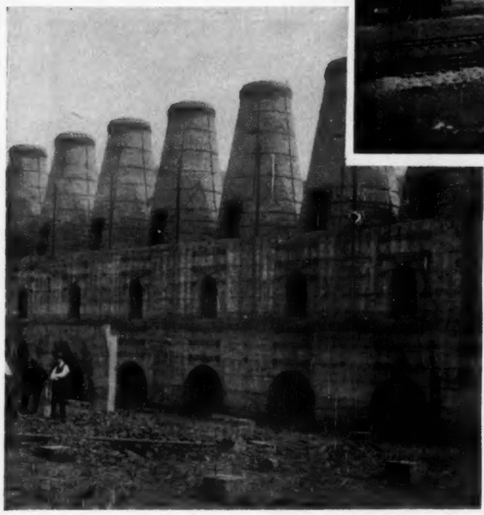
Transforming raw materials into clinker

Manufacturers use either the wet process or the dry process for proportioning and introducing the materials into the kiln. In the wet process the materials are ground with water and the resulting slurry is fed into the kiln. This water is evaporated in the kiln during the clinkering process, thereby adding materially to the fuel consumption. In a dry-process kiln, the heat required to produce a barrel of clinker varies widely from plant to plant, but 1,000,000 Btu may be taken as an example.

High fuel consumption, due to many factors including heat transfer and

future





In American portland cement manufacture, vertical kilns such as those illustrated at left have been replaced by long horizontal rotary kilns of steel. Although the fuel consumption of the rotary kiln greatly exceeds that of the obsolete vertical, the rotary has a better overall economy. A modern cement plant is seen above.

radiation, is characteristic of the rotary kiln. Some fuel has been conserved by increasing the size of the kilns, insulating them, preheating the kiln feed, preheating the combustion air, recovering radiated heat, increasing the fineness of the pulverized coal used for fuel, and increasing the fineness and uniformity of the raw mix fed to the kiln. At best the dry-process rotary kiln is wasteful of fuel; the wet-process kiln is even more wasteful. The dry-process kiln receives 600 lb of solids for each barrel of clinker; the wet process kiln receives the same weight of material plus 400 lb of water in which the material is suspended.

The principal advantage of the dry process of clinker manufacture is the low heat input in comparison with the wet process. On the other hand, the principal advantage of the wet process is the uniform composition of the material fed into the kiln. Finely ground solids suspended in a liquid may be blended easily and accurately. Most cement plants constructed in this country for decades have employed wet-process rotary kilns.

Eventually some better clinkering device will replace the rotary kiln, just as the rotary replaced the vertical kiln. This new clinkerer will reduce the heat input required by the rotary but will retain its advantages. I have two patents on such a device but it must be developed further before it will be ready for commercial use.

Non-aqueous method developed

Several years ago, and after a long search for a method of combining the best features of the wet and dry processes, I determined to make a critical study of the function of the water. Soon it developed that the advantages of the wet process are due to the presence of the mobile liquid, water, which facilitates grinding, blending, pumping, and storage. Each of the disadvantages of the wet process likewise can be traced to the physical and chemical properties of water.

The search for a liquid other than water, in which raw materials can be ground, was started. A group of petroleum distillates appeared to be satisfactory, physically and chemically, and of reasonable cost and availability. The liquid most used is No. 1 fuel oil. A patent on the non-aqueous process for clinker manufacture was issued to me in September 1952. An application for a second patent has been filed, and work under way is likely to result in applications for other patents.

Preparation of water slurry and of nonaqueous slurry are similar, except for the liquid. The raw materials, the proportions of solids to liquid, and the grinding equipment are exactly the same, but the characteristics of the two suspension mediums differ unbelievably.

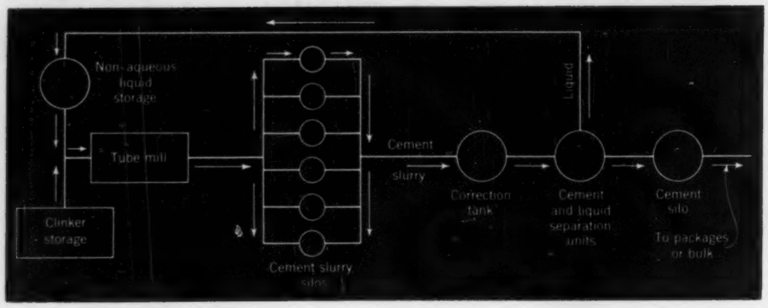
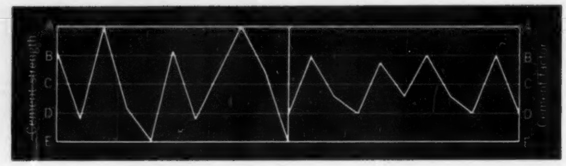
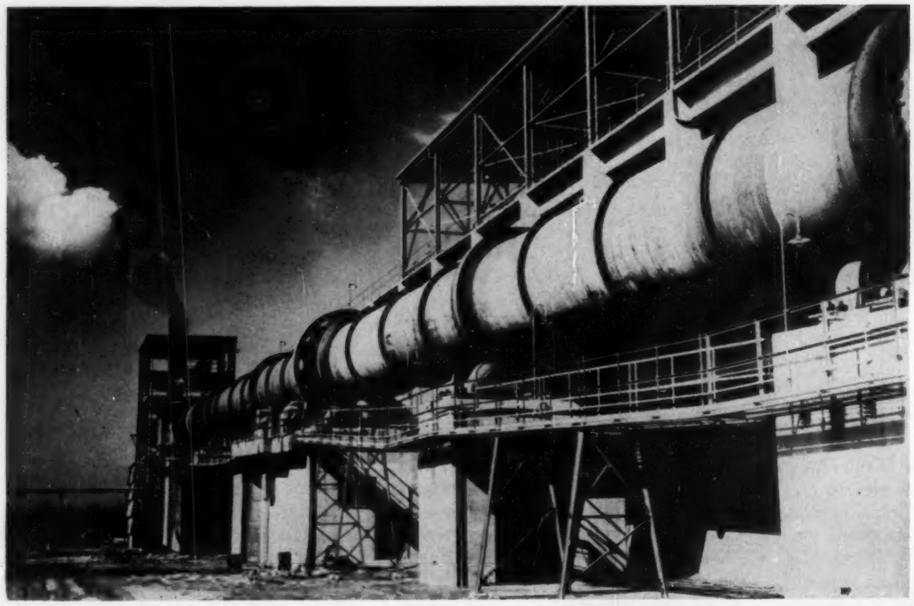


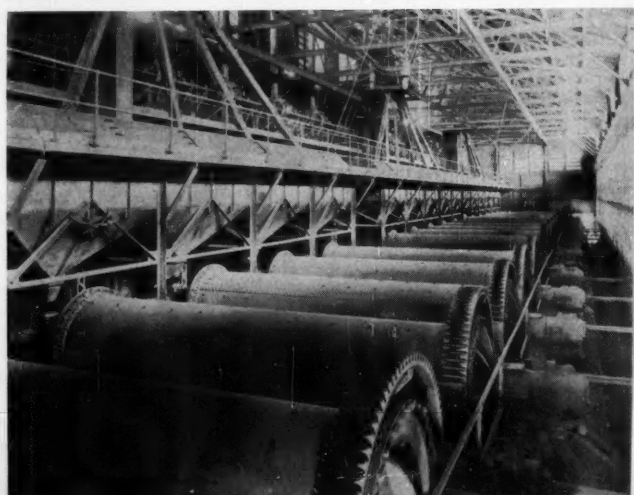
FIG. 2. Non-aqueous process for manufacture of cement from clinker is shown diagrammatically.

FIG. 3. Wide variation in strength is typical of modern cement manufacturing processes, as shown by illustrative curves below. Based on varying cement strength, a factor is chosen such that the desired strength of concrete will be secured with the least possible excess of cement.





Dry-process rotary kiln for making clinker has now been largely replaced by wet-process rotary, such as this one, which is 12 ft in diameter by 450 ft long. A further development is the non-aqueous rotary kiln described in this article but not yet in commercial use.



Here a battery of tube mills grind dry clinker into finished cement. Non-aqueous process gives promise of greatly reducing amount of power needed while at same time providing more uniform and more sharply differentiated types of cement.

Non-aqueous slurry does not freeze and it does not require stirring. The liquid may be separated in a variety of ways. Most of it can be removed mechanically, the remainder being either vaporized, or burned with heat recovery. The saving in heat input is considerable. The non-aqueous process combines the uniformity of product characteristic of the wet process with the fuel economy of the dry process.

Preparation of cement from clinker

The non-aqueous process has two divisions: (1) the preparation of kiln feed, and (2) the preparation of cement from clinker. The civil engineer is concerned primarily with the second, which is explained in the remainder of this article.

Cement may be prepared from clinker by either the dry or the non-aqueous procedure. In the dry procedure, clinker discharged from the kiln is delivered to the consumer with no additional processing except grinding, with the addition of a small percentage of retarder. There is no provision for adjustment or correction. As indicated in Fig. 1, cement discharged from the tube mills is stored in a series of silos, from which it is shipped in sacks or in bulk. Not much blending is possible, and such blending as results is fortuitous rather than systematic.

Obviously clinker cannot be ground in the presence of water. Dry grinding is accompanied by the annoyance of coatings that adhere to the surface of the grinding media; the problem of disposing of the "fringe" cement produced when there is a change from one type of cement to another; and the formation of small lumps of cement in the silos.

Cement grinding from clinker by the non-aqueous process (Fig. 2) eliminates these troublesome features and has the advantage, previously mentioned, that large quantities of finely ground solids can be blended easily in a liquid. The operation has much in common with the wet process for the preparation of the raw material fed to kilns.

In Fig. 2, clinker and a non-aqueous liquid enter the tube mill. The equipment units between the clinker storage and the tube mill are not shown. Cement slurry is discharged from the mill and pumped into the silos. The slurry in any silo is uniform after stirring. Slurry may be drawn from any silo, in any quantity, and transferred to the correction tank. After mixing and checking, the slurry passes through the liquid recovery units. Here the liquid and solid phases are separated. The liquid is returned to storage, and the cement is conveyed to the finished cement silo, from which it is shipped to the consumer in packages or in bulk.

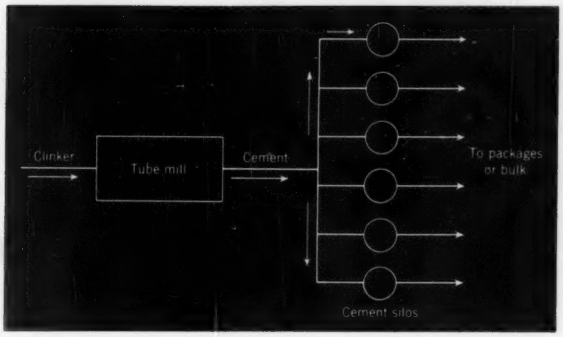


FIG. 1. Dry process for manufacture of cement from clinker is shown diagrammatically.

Uniformity and versatility

Several decades ago the multiple type of cement manufacture started to replace the single type. Today five basic types are recognized by ASTM specifications, and there is no reason to believe that the number of types will not increase. When it is realized that all five types of cement contain the same four oxides and the same four synthetic minerals, the importance of uniformity for each type cannot be overemphasized. Without some degree of uniformity, no one type can be maintained separate from the others in chemical and physical properties.

One of the many reasons why uniformity is so important is illustrated in Fig. 3. No actual values are shown, but actual values are represented. There is no exaggeration. Sometimes it is possible to reduce the strength range materially by changes in laboratory control only.

If the cement compressive strength ranges from A to E psi at 28 days, good practice suggests a cement factor of A sacks of cement per cubic yard of concrete. This calls for more cement than is necessary. However, it is evident that a cement factor of E should not be employed. An average strength calculated on the basis of the data ordinarily available would not be reliable. If the cement strength ranges from B to D, a cement factor of B would mean that the excess of cement would be less; and as the range approaches C, less cement is required.

Regardless of the uniformity of the clinker, more uniform cement can be produced by the non-aqueous procedure than by the dry procedure.

The improved quality of the cements that can now be produced permits corresponding improvements in concrete. The designer now has a wider range of cementitious materials to choose from than ever before.

Although the non-aqueous process was developed for the production of portland cement in general, it now appears to be particularly adapted to special cements, such as white, high alumina, oil-well, blended, and masonry—with all of which I have had experience. The advantage of the new method is especially marked when one raw material is much more expensive, difficult to obtain, or relatively less in quantity than the others.

From time to time cement users have requested some modification of existing cements by grinding with them small percentages of various types of admixtures, such as pigments, for example. In many cases such requests have been considered economically impracticable. The new process changes this situation materially.

Although the foundation has been laid for improvements in the manufacture of portland cement as here described, no one can say what the eventual development will be. Great advances in concrete technology have been made in the past few decades. The new processes for the manufacture of cement should aid in making even greater strides forward in the decades to come.

[Some of the material in this article is taken from Dr. Witt's book, *Portland Cement Technology*, published by the Chemical Publishing Company, New York, 1947; and some of it appeared in an article by him in *Mechanical Engineering*, Vol. 77, page 828, 1955.]

Theory and building code specifications compared

EARTHQUAKE FORCES in a tall building

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An analytical investigation of the importance of higher modes of vibration in the earthquake response of a tall building was recently completed by the writer. (The results of this investigation will be published soon in the Bulletin of the Seismological Society of America.) One by-product of this study may be of interest to the civil engineering profession, that is, a comparison between the earthquake forces determined by analytical methods and the design forces specified by two different building codes.

Stated simply, the objective of the aforementioned investigation was to determine what would have happened to an actual building if it had been subjected to a given actual earthquake motion. The Alexander Building in San Francisco was selected for the study because it is a relatively tall, slender, symmetrical structure, and its elastic mass properties had been carefully evaluated by previous investigators. The basic dimensions and weight data of this building are given in Fig. 1. The ground motion used in the analysis was that observed in the east-west component of the El Centro, Calif., earthquake of May 18, 1940. This earthquake was chosen because it was one of the strongest quakes from which adequate records have been obtained, and the ground acceleration data were available in punched-card form.

The response of the structure to the ground accelerations was computed by means of digital computers, using the mode-superposition method and considering only the first three modes of vibration. (Results of the investigation justified this approximation, for it was found that the second and third modes together contributed only about 15 percent to the total response, and it may be assumed that the higher modes would have even less significance.)

The amount of damping present in the structure is not known, but it is certain that damping has a very important effect on the response. For this reason, various amounts of damping were assumed in each of three modes. Six different cases were considered, involving different combinations of the damping values for each mode, as are shown in Table I.

For the purpose of comparing the theoretical response with the building code specifications, the maximum total shear forces developed at the various floor levels by the earthquake were calculated. These theoretical results were compared with the shearing forces specified for designing this structure against earthquake by two different codes: The Uniform Building Code (Pacific Coast Building Officials Conference, 1952 edition, p. 280) and the code proposed by a Joint Committee of the Structural Engineers Association of Northern California and the San Francisco Section, ASCE (*Transactions*, ASCE, Vol. 117, 1952, p. 747). In the discussion which follows, the Uniform Building Code and the proposed code of the Joint Committee will be designated as UBC and JCC respectively.

The comparison between code and theory is most meaningful if made in two parts: (1) the manner in which the shear forces vary through the height of the structure, expressed in terms of a base shear of 100 percent, and (2) the magnitude of the base shear. A comparison of the manner in which the shear forces vary with height is presented in Fig. 2. Two theoretical curves are presented, the average of Cases C and D, and the average of Cases E and F, because there is no way to determine which is more reasonable. The principal conclusion to be drawn from this comparison is that both codes check quite well with either theoretical curve, and hence that the method of varying the seismic forces with height specified by either code may be considered satisfactory.

A comparison of the magnitudes of the base shear forces expressed as percent-

TABLE I. Combinations of damping ratios considered

Mode	Damping Ratios for Each Case*					
	A	B	C	D	E	F
1	0	4	7.5	15	2	4
2	0	4	7.5	15	7.5	15
3	0	4	7.5	15	15	25

* The damping ratio represents the ratio of the assumed damping coefficient to the critical damping coefficient, expressed in percent.

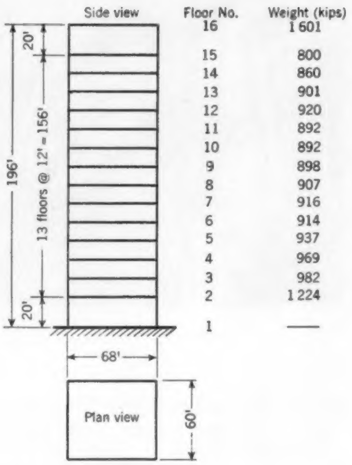


FIG. 1. Basic dimensions and weights are given for Alexander Building in San Francisco, Calif. This building was chosen for the earthquake study because it is a relatively tall, symmetrical structure, and its elastic and mass properties had been previously evaluated.

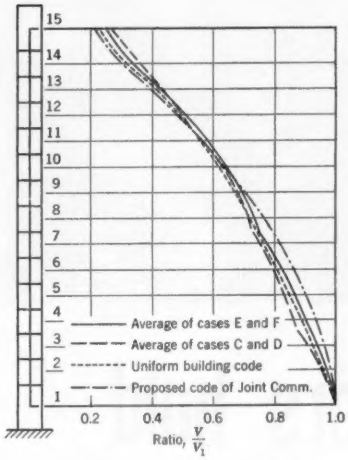


FIG. 2. Manner in which earthquake-induced shear forces vary with height is plotted for Alexander Building in San Francisco. Two theoretical curves are presented (average of Cases C and D and of Cases E and F) because there is no way to determine which is more reasonable. It is evident that both codes check quite well with either theoretical curve. Hence the method of varying seismic forces with height specified by either code may be considered satisfactory.

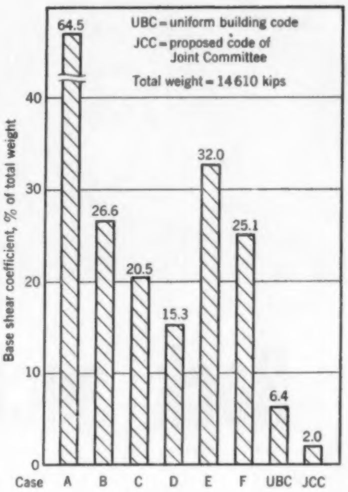


FIG. 3. Magnitudes of base shear forces, expressed as percentages of total weight of building, are compared. Variation in theoretical results for Cases A through F demonstrates very important effect of damping. Coefficients for UBC and JCC must be interpreted in light of fact that these codes are based on experience rather than theory, and allow for some damage to building, though not to any major structural element.

ages of the total weight of the building is shown in Fig. 3. The variation in theoretical results found for Cases A through F demonstrates the very important effect which damping has on the response of the structure. A comparison of Cases B and F shows that the degree of damping assumed for the first mode plays the primary role in controlling the total response, since the different values of damping ratio used in the second and third modes for these cases caused very little change. On the basis of what little is known about damping in buildings, Cases C and D may be considered to give the most realistic values of base shear coefficients for the structure. The results found for Case A, assuming no damping, are completely unrealistic.

The comparison in Fig. 3 between the theoretical values and the base shear coefficients specified by the building codes might lead one to question the safety of these earthquake provisions, since the UBC coefficient is only about 40 percent as great as the smallest theoretical value, and the JCC coefficient is only a third as large as the UBC. Before any conclusions can be drawn from this comparison, however, it is necessary to have some background on the manner in which these code provisions were established. The basis of their adoption was the considered opinion of a group of experienced engineers, after an extensive study of buildings which had been subjected to earthquakes, that a structure designed according to these specifications would have adequate earthquake resistance.

It was expected that a major quake might cause some damage to a structure designed according to the code, but it was not expected to cause failure of any major structural element. In effect, it was recognized that seismic forces greater than those specified by the code might be developed, but these excesses would be offset by the factors of safety contained in the design loadings, in the allowable stresses, and in the resistance to lateral load provided by non-structural elements.

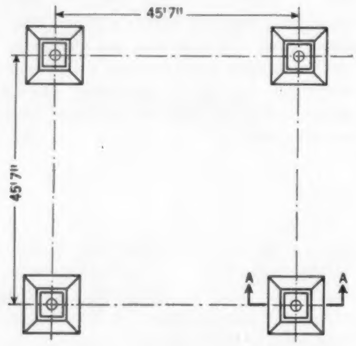
An additional explanation of the discrepancy between code and theory, which may be even more important than the above, lies in the fact that the theoretical analysis assumes the structure to respond *elastically* to the earthquake. Actually, in an earthquake of this magnitude, cracking of some non-structural elements (plastered partition walls, for example) is to be expected. This would cause a reduction in the rigidity of the building and therefore an increase in its period of vibration. As a result, resonant amplification of the building motions would be suppressed every time the stresses reached the critical value where cracking occurred and the period of vibration was altered; and the large forces calculated in this investigation would never be reached. Thus it is seen that this method of analysis does not accurately predict the response of an actual building structure to a relatively severe earthquake. It is now proposed to extend the investigation, taking into account the inelastic action of the structure, in order that a better check may be obtained with the building code specifications.

In conclusion, it should be reemphasized that this investigation has not proved the building codes to be unsafe. As has been explained, the forces actually developed during a strong earthquake are expected to be somewhat higher than those specified by the codes. In addition the theoretical calculations tend to exaggerate the earthquake effects by assuming completely elastic action. However, the writer believes that the results also tend to indicate the need for more research along these lines before relatively conservative code values such as those specified by the Uniform Building Code are abandoned in favor of such apparently minimal requirements as those proposed by the Joint Committee.

1

Rock anchors hold TV tower on Mt. Wilson

FIG. 1. Four-pad anchorage ties tower to solid rock at each corner. Cross section AA appears in Fig. 2.



A. E. SCHMIDT

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FIG. 2. In each of four anchorages, eight $^{3}/_{4}$-in. high-strength rods are grouted to depth of 25 ft into solid rock and are bolted at top to lower base plate. Upper and lower base plates are tied together by eight 3-in. bolts. Base plates, by Lehigh Steel Co., are 40 in. square and $4^{1}/_{2}$ in. thick.

When NBC decided to construct a television antenna tower with an overall height of over 532 ft on top of Mt. Wilson, various problems of design and construction had to be solved. The site itself, on top of the mountain made famous by the world-renowned observatory, provided a minimum of usable area, making it difficult to use guy wires. Since winds often reach a high velocity, the safety factor involved was of the greatest importance. Three types of basic construction were considered:

1. Reinforced-concrete reservoir base. Using an excavation measuring 70 by 70 ft, engineers could construct a steel-reinforced concrete tank, to be filled with 100,000 gal of water and capped. The relatively high cost, estimated at $70,000, caused the engineers to question this plan.

2. Mass concrete footing. A broad base composed of approximately 700 cu yd of concrete could be poured on top of the mountain at an estimated cost of $56,000. Not only would the cost be high, but transporting the premixed concrete up the mountain loomed as a herculean task. One engineer even suggested the use of helicopters to carry buckets of concrete from a nearby site.

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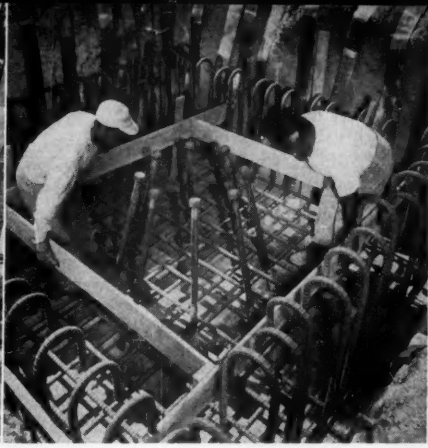

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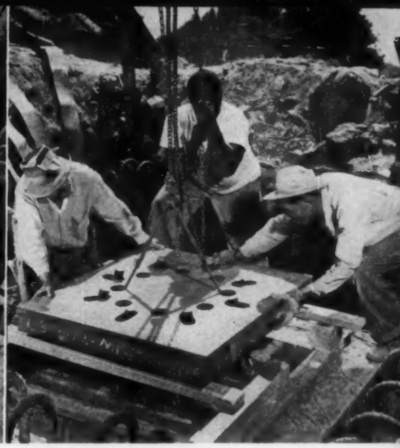

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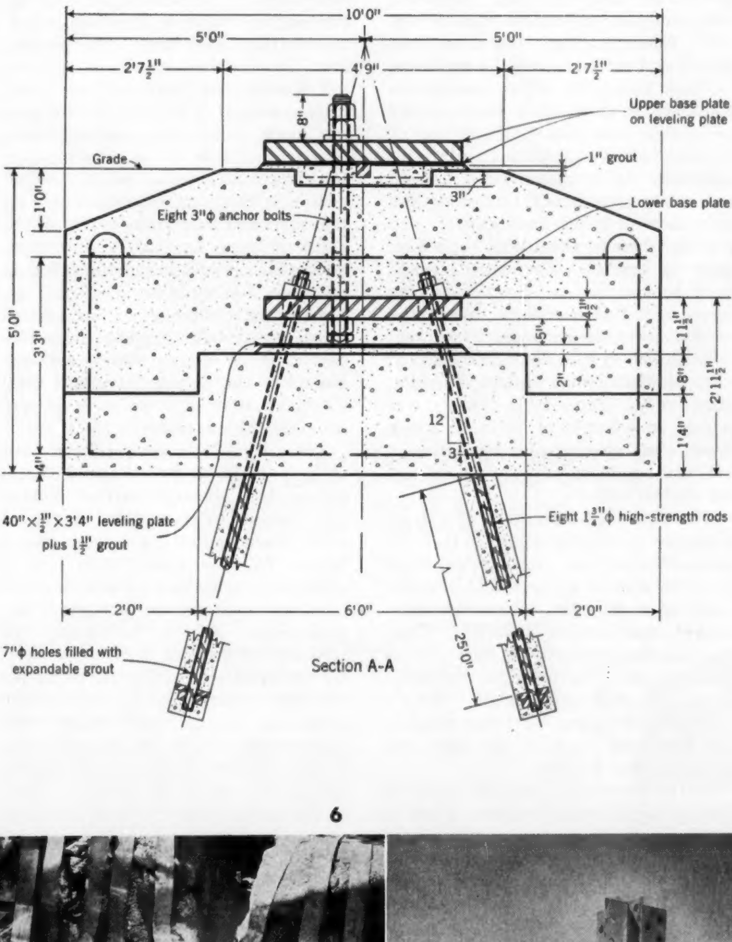

Section A-A

In excavation 10 ft square and 5 ft deep, 5-in. layer of concrete was poured as base for jacking operations. Then eight anchor holes of 7-in. diameter were angle drilled to depth of 25 ft and high-strength rods placed. After pouring expandable grout to height of 10 ft, all rods were tested to 60 tons, some to 80 tons, as shown in Photo 1. Copper grounding system was next placed (Photo 2), then network of No. 8 steel reinforcing bars spaced 8 in. each way (Photo 3). In temporary wooden frame, bottom tier of concrete will be poured, followed by placing of lower steel base plate, $4^1/_2$ in. thick, shown being slung into position in Photo 4. Eight oval slots in base plate are for $1^3/_4$-in. high-strength rods which terminate above this plate. Inside circle of holes is for vertical 3-in. anchor bolts, which connect lower and upper base plates. See Fig. 2. In Photo 5 is seen special jack support designed to permit stressing of rods to 80,000 lb and tightening of nuts while stress remains in rod. View after second pour (Photo 6) shows temporary plate in place to control position of anchor bolts and to guide final elevation of pour. Next step was placing of upper base plate and stub, seen in position in Photo 7. Note important leveling screws at corners of plate. In Photo 8, anchorage for near corner of tower has been completed.

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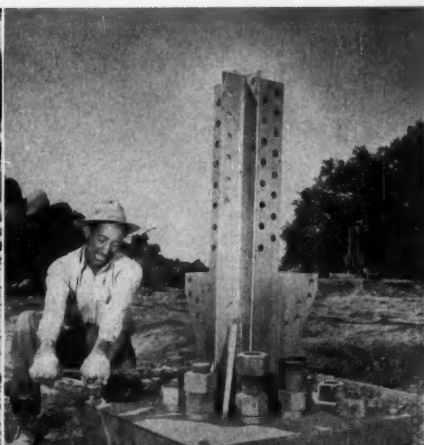

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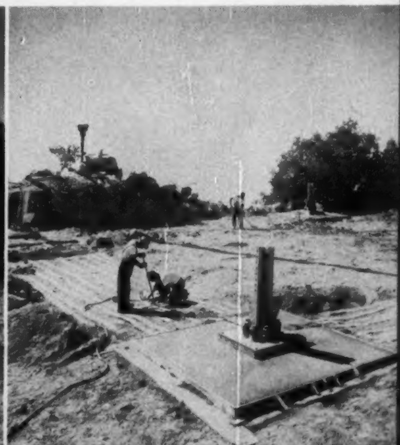
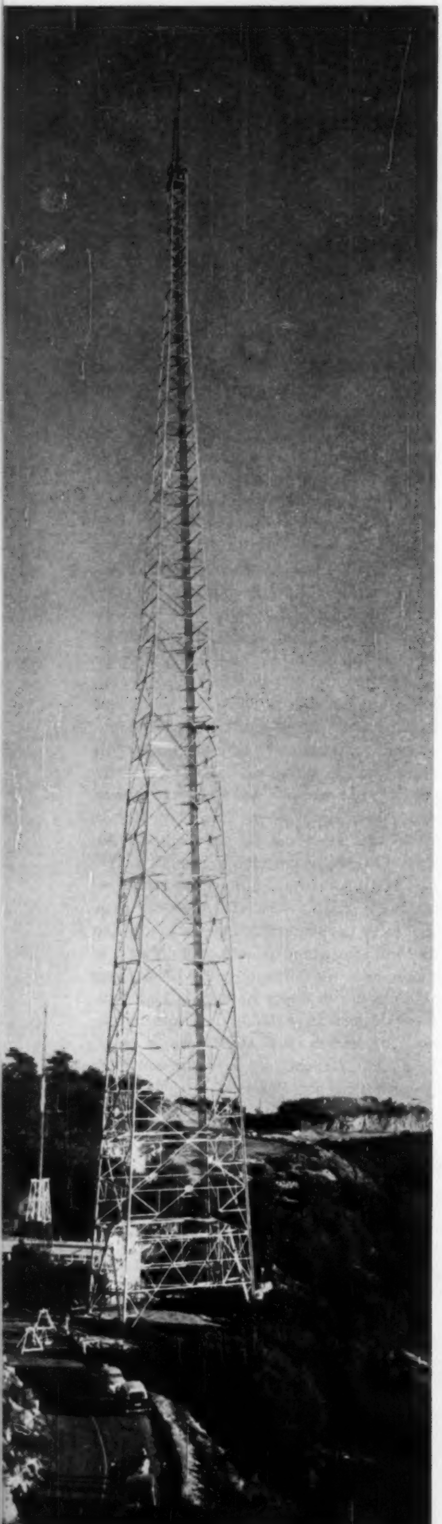




Four-pad direct anchor base for NBC's 532-ft TV tower on Mt. Wilson was designed and constructed by The Austin Company. Anchor rods, eight at each corner pad, were bonded to rock at depth of 30 ft. Safety factor of 3 is provided against even extreme winds with tower coated with 2 in. of radial ice.

3. Direct anchor, using individual four-pad system. Because a virtually solid rock formation underlies the area on top of Mt. Wilson, the tower could be anchored directly to the rock. The estimated cost of only $31,500 was well below that for the other two methods considered and was a big factor in the decision arrived at by NBC and The Austin Company, which had been engaged to design and build the foundation.

The method chosen eliminates the need for guy wires. See Fig. 1 for plan of anchorage and Fig. 2 for cross section through one anchorage pad. When the individual pad system was approved by NBC, Austin engineers had a test hole drilled and an undisturbed core taken for each base point. Tests were then made which disclosed a bond of 286 psi—much more than sufficient.

At the site of each of the four legs, an excavation 10 ft square and 5 ft deep was made preparatory to drilling the eight holes for the anchor rods. To provide a base for the drilling rig, a 5-in. layer of concrete was poured, which later became a base for the jacking operation. For maximum safety, the anchor holes, of 7-in. diameter, were angle drilled to a depth of 25 ft and the rods terminated with washers of $6^1/_2$-in. diameter. Expandable grout was poured to a height of 10 ft, at which point, after allowing time for setting, a jack was employed to prestress and test the anchor rods.

The hot-rolled steel rods, of $1^3/_4$-in. diameter, checked in regard to their resistance to corrosion, were tested, in all cases, to at least 60 tons, and in a few cases up to 80 tons. These rods meet ASTM Specification A193-B7. When the load was removed, the rods were in the same position as to height, indicating no slipping of the grout or rod. With a more than sufficient bond thus assured, the remaining 15 ft of the hole was grouted using Embeco.

At this point NBC engineers installed the copper grounding system on top of which a network of No. 8 steel reinforcing bars was positioned at 8-in. intervals each way. In a temporary wooden frame, the bottom tier of concrete was poured and followed by the placing of the lower steel base plate having a thickness of $4^1/_2$ in.

A problem arose at this point regarding the method for tightening the nuts on top of the beveled washers. The foundation hole, only 10 ft square, prohibited the use of a torque wrench with a handle long enough to get the proper purchase. Austin engineers then devised a jack support arrangement which enabled the installation engineers to prestress the rods up to 80,000 lb and tighten the nuts while the stress remained on the rod. Removing the stress tied everything down in first-class shape. The combination of double stressing and double grouting helped to add to the safety factor of the foundation.

Following the placing of the 3-in. column anchor bolts, the second pour was made, using the temporary plate shown in Photo 6 as a screed to guide the final elevation of the finished pour. At this stage of construction all that remained was the mounting of the upper column base plate and stub, after which grouting and the filling of the shear slots could begin.

With the tightening of the column tower anchor bolts, grading of the site and capping of the foundation, engineers of the Lehigh Structural Steel Company were able to move in and complete the remainder of the tower.

These bases were designed and built with a concern for ultimate stress rather than allowable stress. Taking into account the recorded highs of wind velocity and the resistance offered by the TV tower coated with 2 in. of radial ice, engineers were able to arrive at a net uplift on any one leg of approximately 527,700 lb. Using the common estimate of 150 lb per cu ft for the weight of rock, it was estimated that the volume of rock to which each tower leg was anchored would weigh approximately 1,900,000 lb, providing a safety factor of about three against the lateral force of the wind.

The contract for the design and construction of the tower foundation was let in April 1954 to The Austin Company of Los Angeles, and the work was carried out under the direction of J. K. Gannett, M. ASCE, the company's vice president and director of engineering and research. Work on the four individual foundation pads was completed just 12 weeks after approval of the final plans.

NBC has been using the completed tower to transmit programs since December 1954. The 532-ft height of the tower, plus the 5,677-ft height of Mt. Wilson, enables NBC to cover a radius of approximately 125 to 150 miles.

Heavy construction goes to sea

First Atlantic radar platform installed on Georges Bank

GORDON F. A. FLETCHER, M. ASCE, Assistant Vice-President, Raymond Concrete Pile Company, New York, N. Y.

The first offshore radar station for early aircraft warning has been turned over to the Air Force, which will complete the electronic installation (not included in the construction contract). Officially identified as U.S. Air Force Station, Georges Bank, Texas Tower No. 2 has been under design and construction since January 4, 1955.

The idea of constructing radar islands off the New England coast for early aircraft warning was an outgrowth of the Lincoln Project at Massachusetts Institute of Technology. Off the coast there are fishing banks and extensive shoal areas surrounded by waters of great depth. The basic idea was to use certain shallow areas for radar-equipped platforms. Although such installations would be Air Force facilities, their construction would be a marine operation. Consequently, the Bureau of Yards and Docks of the Navy was selected to determine the feasibility of constructing such radar platforms and, subject to their conclusions, to contract for the design and construction of a limited number. The proposed radar platforms have become known as, and are here referred to as, Texas towers because of their resemblance, in certain respects, to the oil-well platforms constructed in the Gulf of Mexico.

The first step undertaken by the First Naval District, at Boston, was to engage an architect-engineer group to investigate the many problems and to submit a feasibility report covering five selected sites. The advice and assistance of the Woods Hole Oceanographic Institute were of great value to all concerned in these and subsequent studies.

Since a knowledge of the geology and soil conditions of the shoals was essential for the design of the foundations, a contract was negotiated by the First Naval District with a joint venture under which borings were made on two of the selected sites, one at Georges Bank and the other on Nantucket Shoal. These were the only two sites

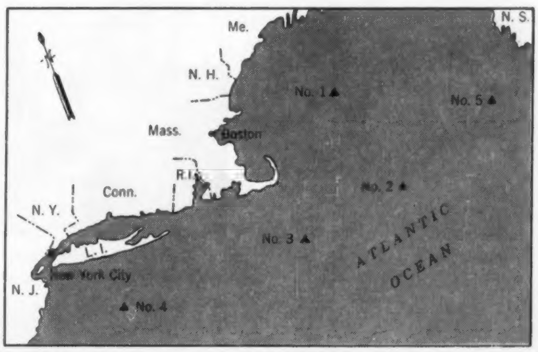
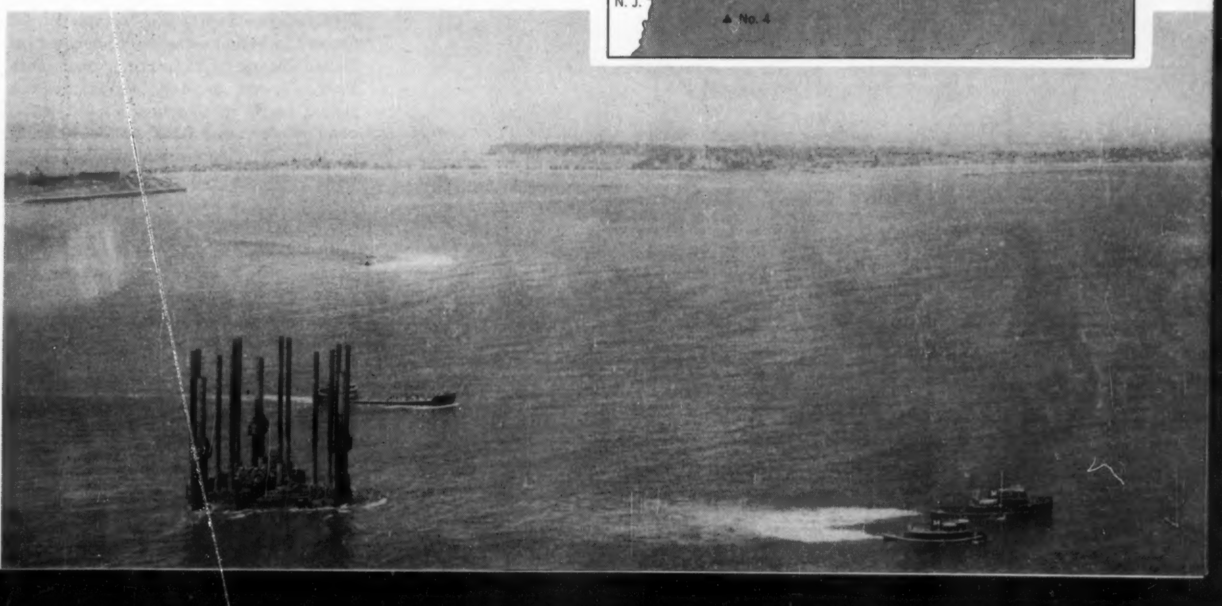
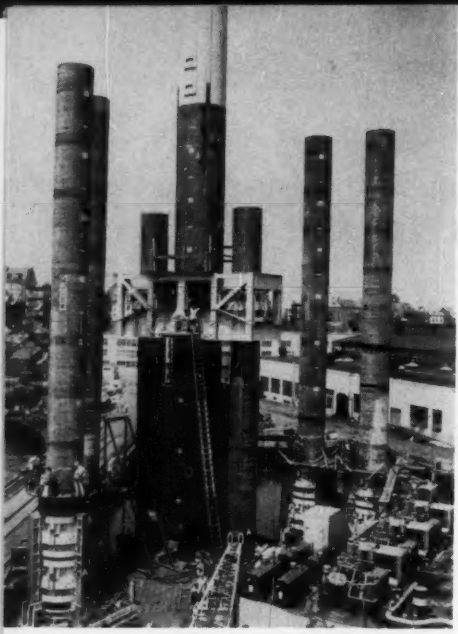


FIG. 1. Five "radar islands," called Texas towers, are located on shoals in North Atlantic. First to be completed is No. 2, which is here described.



Two tugs head seaward with platform in tow. Temporary caissons 195 ft long extend 165 ft above deck and about 10 ft below it. Permanent caissons 180 ft long extend about 150 ft above deck and 10 ft below. Crew of 35 sailed aboard platform on trip which took slightly less than three days.



on which it was practical to make borings in the prehurricane season of the summer of 1954. The borings revealed the soil conditions to depths of 120 ft below the ocean floor.

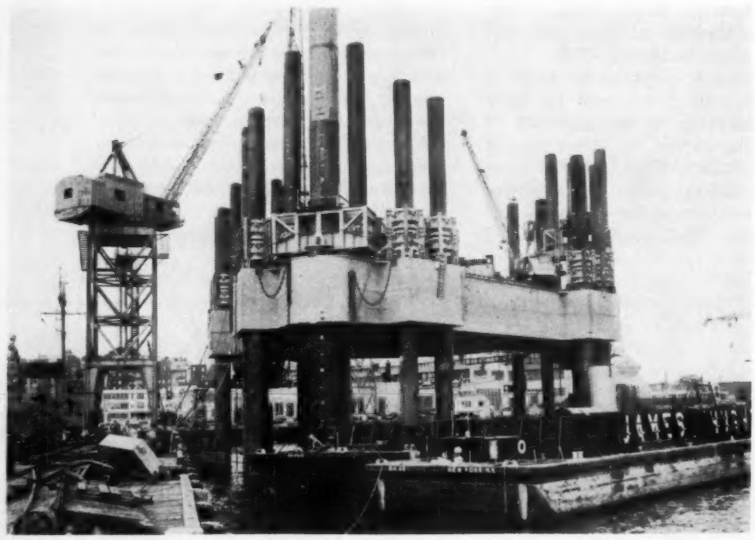
Towers located on shoals

Texas tower No. 1 will be located in 50 ft of water on Cashes Ledge, a rock outcrop, 75 miles east of Portland, Me. Texas Tower No. 2, the first one completed, is situated on Georges Bank in 56 ft of water, 160 miles east-southeast of Boston. Texas Tower No. 3 will be located 80 miles southeast of Nantucket in 80 ft of water. Texas Tower No. 4 will be off Long Island 70 miles east of Ambrose Light in 180 ft of water, and Texas Tower No. 5 will lie 200 miles east of Boston on Browns Bank, in 130 ft of water. See Fig. 1.

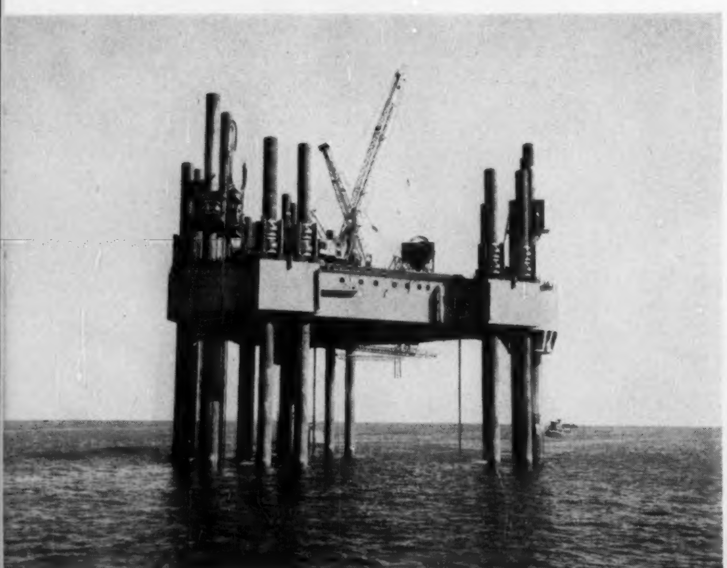
The shoal areas under consideration have appeared on mariners' charts as far back as such charts have been in existence; it therefore seems unlikely that the banks will move or become subject to erosion.

Construction methods in the North Atlantic bear no resemblance to harbor or coastal operations. There is never any slack water between tides. The tidal currents run from 3 to 5 knots and continually change direction so that they rotate clockwise through a full circle every 12 hours. There is never a

Tower is seen under construction in an East Coast shipbuilding yard. At each corner, permanent 10-ft-diameter caisson is flanked by two smaller stub caissons which will be used in jacking permanent caisson down 50 ft below ocean floor. On each side of this group are two temporary caissons running through bracket which extends out from platform proper. These caissons, when resting on ocean floor, will be used to jack platform up 81 ft above water surface.



Platform could not be completed at Quincy, where it was built, because of limited clearance of a bridge over Fore River. Towed to East Boston, it was jacked up 35 ft, as shown above, so that contractor's cranes could extend caissons to their full length while other work underneath the platform was completed.



In final position on Georges Bank, 160 miles east-southeast of Boston, platform is supported on 12 temporary caissons, four at each corner, while permanent caissons are driven down 48 ft below ocean floor.

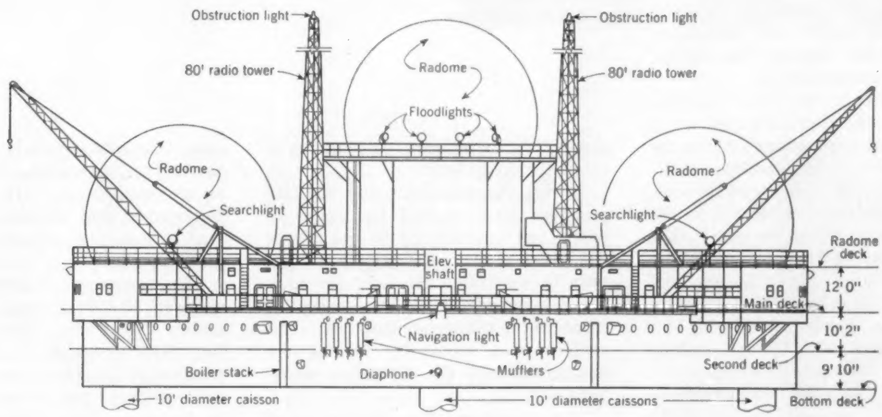
dead calm. Ground swells are continuous and of various heights. Superimposed on the swells are the local wind waves, resulting in total wave heights of 6 to 8 ft on the best of days. At times the waves are 35 ft high with winds up to 60 miles an hour. Another feature of these shoal areas is that they are shrouded in fog a considerable part of the time. To navigate them, ships must be equipped with fathometers, radar and loran instruments.

Typical tower design

The typical tower platform is a triangular structure, approximately 200 ft long on each side, with a height of 20 ft, thus providing two decks. The upper deck is for living quarters, galley, mess hall and recreational facilities, and the lower deck for power plant, boiler rooms, fuel and water tanks, storage, etc. Covering a part of the main deck is a deckhouse 60 ft wide and 200 ft long containing offices and operational facilities and supporting the three unique radomes, the equipment in which is classified. Other facilities on this deck are the radio antenna masts, two 80-ft boom derricks with constant-tension winches, and disk antennas. That part of the main deck outside the deckhouse is kept clear of obstructions for the use of helicopters. Under the platform there is a revolving bridge to permit access to all under-side facilities as well as to the three supporting caissons.

The general structural design of the platform is shown in Fig. 2. It will be seen that there is a bay formed between the exterior structural girders and the next interior members, which houses the living quarters on the upper deck and the motor generator rooms, boiler rooms, fuel and water tanks on the lower deck. As constructed on the shipways, a camber was built into the structure (making it 2 in. higher in the middle), so that, when supported on its caissons, the decks would be virtually level between points of support.

At each corner, the 10-ft-diameter caissons extend through 15-ft wells in the platform, and the moment connec-



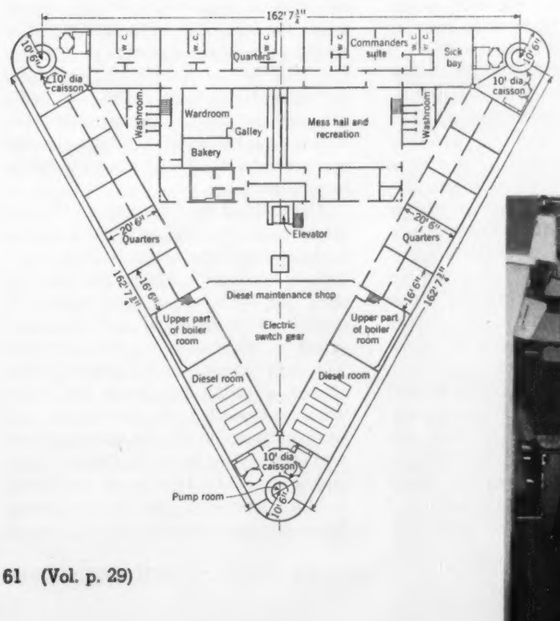


FIG. 2. Platform for Texas Tower No. 2 has two floors. Bay formed between exterior structural girders and next interior members houses living quarters on upper deck and generator and boiler rooms on lower deck. Photo shows mess hall. Tower is self-sustaining home for 70 officers and men of the Air Force.

tion is provided by vertical web plates set in the annular space and fitted and welded in place at the site using low-hydrogen welding rod. The use of this type of connection between the structure and the caissons at their upper ends, together with the established embedment of 48 ft into the hard sand bottom at their lower ends, eliminated the need for the diagonal bracing originally contemplated.

The permanent caissons are coated on their lower ends and have monel cladding in the splash zone. To protect these areas from abrasion while the caissons were passing through the wells in the platform, guide bars were attached to the caissons, and further control was provided by heavy pins set in the caisson well extensions and also at the upper deck level. These pins could be adjusted by jacking to guide and control the caissons during sinking. While all the towers will be supported by three permanent caissons, differing water depths and foundation conditions at the different sites call for variations in caisson design.

On December 31, 1954, the Bureau of Yards and Docks awarded a contract to an East Coast shipbuilding concern for the fabrication of the platform structure, including the permanent caissons, all the permanent equipment, and the interior outfitting. At the same time the Bureau awarded a separate contract to a joint venture of two marine contractors for furnishing the temporary caissons, the special equipment for raising the platform, towing, sinking the caissons, and final outfitting.

In general it was the marine contractor's plan to raise the platform by attaching caisson brackets on each side of the three corners, each bracket carrying two temporary caissons equipped with air jacks. The platform was to be elevated and supported by the temporary caissons until the permanent caissons had been installed and the load of the platform transferred to them. The temporary caissons and their brackets would then be removed.

Two major construction problems

The major questions confronting the contractors were:

1. With the permanent caissons over 180 ft long, and the temporary caissons 195 ft long, extending 165 ft in the air above the deck, what would the towing characteristics be? And how stable would the structure be under varying conditions of wind and wave?

2. How should the platform be raised 87 ft above the sea, and the permanent caissons (weighing over 500 tons apiece) lowered to the ocean bed? What would be the best procedure for sinking the permanent caissons 48 ft below the ocean floor?

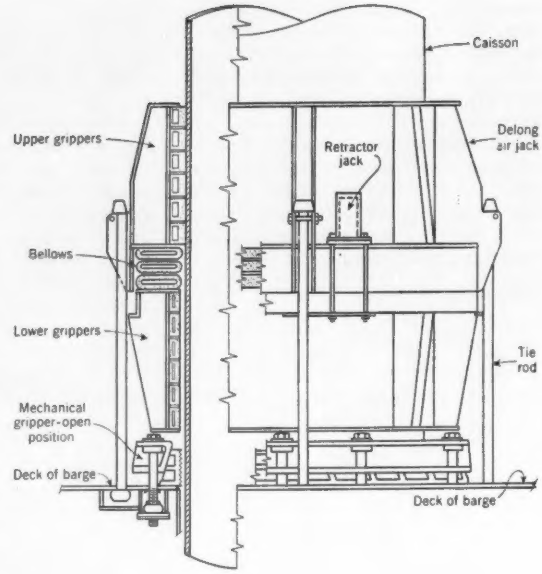


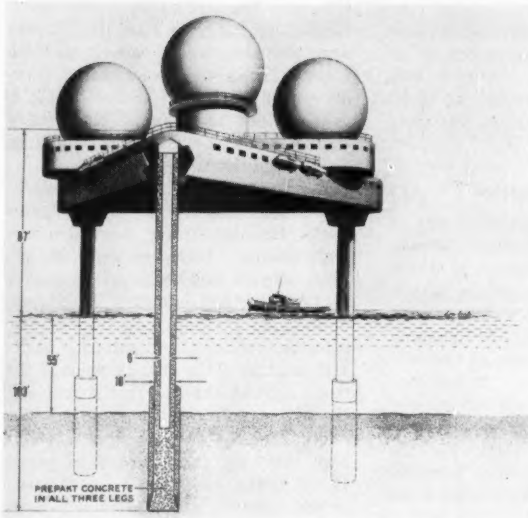
FIG. 3. Air jack of 300-ton capacity was vital factor in raising platform on caissons. Jack consists of three main parts—upper inflatable rubber gripper, expandable and retractable bellows, and lower inflatable rubber gripper.

Towing characteristics and stability problems were studied by means of model tests carried out in one of the test tanks at Stevens Institute. These tests demonstrated the need for additional buoyancy at the bow or leading corner of the triangular structure. This problem was solved by making the brackets on each side of the bow watertight.

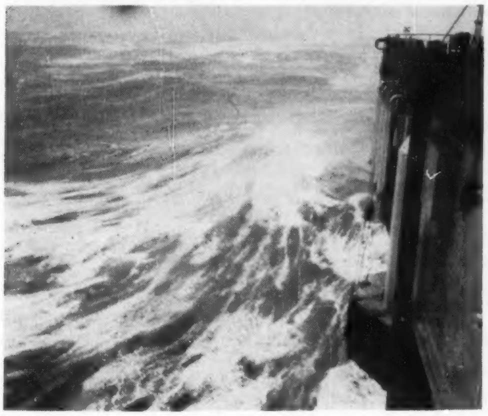
The second problem, the raising of the tower, was solved in the following way. In each of the six temporary caisson brackets, there were two caissons of 6-ft diameter. On each of the temporary caissons there were two air jacks each of 300-ton capacity (Fig. 3). An air jack consists of three major components: (1) an upper section containing an inflatable rubber gripper enclosed in a steel housing, which is fastened to the caisson bracket with a structural tie-beam; (2) a lower section, also composed of a rubber gripper in a steel housing; and (3) between these two sections, an expandable and retractable bellows. The action of an air jack is often compared to that of a boy shinnying up a tree. The lower gripper is expanded by high-pressure air so as to grip the 6-ft caisson; air pressure in the upper gripper is then relaxed; and air forces the bellows to expand, pushing the upper gripper and the structure up several inches. The upper gripper is in turn expanded, and the lower gripper deflated and raised an equal amount by the contraction of the bellows. Compressed air is supplied by a battery of compressors which produce air at over 200 psi. The air system is so arranged that all jacks can be operated by a central control or any pair of jacks separately.

The permanent caissons are steel cylinders 10 ft in diameter and approximately 185 ft long. Corrosion protection was provided by monel metal cladding in the splash zone. The lower end was flared out to form a bell 15 ft in diameter. An outside steel shell 15 ft in diameter encircles the lower 63 ft of each caisson. Through the annullar space thus formed, 8-in. sleeves were set so that jets could be introduced inside the bell, close to the cutting edge. In the same space a system of lubricating jets, so as to permit controlled jetting on the outside of the 15-ft cylinder, were installed. The annullar space between the bell and the outside cylinder was partially filled with concrete before leaving port.

The method used to support the permanent caissons during the tow and to lower them to the ocean bottom was a unique application of the air-jack system. On each side of each permanent caisson, a cylinder of 6-ft diameter, called a stub caisson, was installed. The stub caissons, each 70 ft long, supported a structural frame or bridge which surrounded the permanent caisson and to which the permanent caisson was attached by large steel pins. Each end of the bridge held an air jack which in turn encircled the stub caissons. Thus, by operating the air jacks up or



Three steel legs support 6,000-ton platform carrying radomes. As shown at left, bottom part of each leg and space between inner and outer shells is filled with Intrusion-Prepakt concrete. In recent storm (photo below) 35- to 60-ft waves delayed departure of inspection group five days.



down on the stub caissons, the permanent caissons could be raised or lowered.

The stub caissons were later set inside the permanent caissons and used as forms, and the annullar space around them was filled with concrete. The space inside them, 6 ft in diameter, was used for salt water and fuel oil intakes, and other utilities.

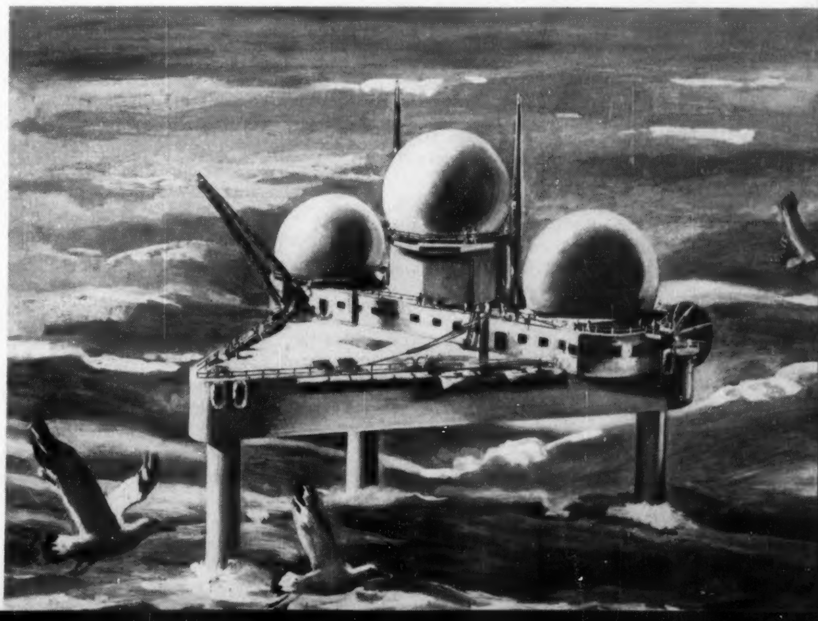
In the towing position, the permanent caissons extended 10 ft below the bottom of the platform. From the time each caisson was set in place until the permanent caissons were installed to their final elevation and welded off, the whole operation depended on the continuous functioning of the air-jack system. For each of the temporary caissons, mechanical grippers were provided, which could have been set in the event of failure of the compressed air system.

Because of the deck space required by the permanent caissons and the stub caissons, only the center section of the deckhouse was completed in the shipyard, and the ends of the deckhouse were left to be completed at sea.

It was not possible to install the temporary brackets on one side of the platform at Quincy, where it was built, because of the limited clearance of a highway bridge over the Fore River. The platform was towed to East Boston, where the remaining brackets were attached, the temporary caissons installed through these brackets, and the platform raised so as to clear the water by about 35 ft. This operation was necessary so that the contractor's cranes could extend the caissons to their

With permanent caissons driven down to final position, brackets supporting temporary caissons were burned free. Here one is about to fall into the sea. Having been previously sealed, caissons will float and will be towed ashore.

Radar islands are vital links in warning system to prevent surprise air attack. First such tower to be erected stands on a shoal (Georges Bank) in Atlantic, exposed to full force of wind and wave. Platform is 200 ft long on a side and 81 ft above water.



full length, and so that the caisson well extensions and monorail could be completed underneath the structure and the permanent caissons extended. Therefore all but 24 ft of each caisson was welded into place. The butt welds in the caissons were extremely critical because of the bending moments and were X-rayed to ensure their integrity.

Long before sailing time, the approximate location of the tower had been determined and soundings made by the Woods Hole Oceanographic Institute. Shortly before departure, the area was marked with a buoy set by the Coast Guard. An Oceanographic vessel, with a representative of the contractor's private weather service, stood by reporting weather conditions until the arrival of the platform.

Tower under tow

The structure was towed to sea astern two 1,800-hp tow boats. A crew of 35 sailed on the platform, including supervisors, various operating crafts, cooks, and the doctor. The tow took a little less than three calendar days to cover the 160 miles. Weather conditions were ideal.

The contractual obligation was to locate the platform within 200 ft of the marker buoy and to orient it within 5 deg of a given bearing. With the assistance of a Sperry gyroscopic compass and a skilled operator, and aided by an anchorage system, the temporary caissons were dropped within the desired area and the platform was jacked up well within the required tolerances.

Because of a mishap on the launching ways, Texas Tower No. 2 left East Boston behind schedule with one third less time to be securely positioned than had been expected. Research into the weather history of this area established August 10 as the earliest recorded date of hurricane storms.

Since the bottom deck and the exterior bay on all three sides of the first deck had been sealed up by welding to provide watertight integrity during the tow, the first task was to open up the structure for power, light, heat, and quarters and make these facilities ready for full-scale operation. At the same time, the first shipload of additional labor arrived, including personnel to make borings. The selected site was not close enough to the area checked by borings in the summer of 1954 to take a chance of encountering changed soil conditions.

Promptly after landing the permanent caissons on the bottom, stone was placed between the 10-ft caisson and the 15-ft outer shell and concreted by Intrusion Prepakt method, using salt water. All subsequent concreting was done by this method. However, fresh water was used where the concrete was classified as structural concrete.

The platform was then jacked up to 81 ft above sea level. Since it was located in 56 ft of water instead of 50 ft as expected, the height of 81 ft was established instead of 87 ft.

Hurricane season approaches

The next major undertaking was to sink and concrete the permanent caissons since delay or failure in these operations, with the hurricane season approaching, could wreck the project. It was realized early in the planning stage that the rapid sinking of the caissons was vital to success. It was concluded that to depend on one scheme alone was not prudent. Consequently, two methods and the equipment for them were planned. A very powerful jet which could be rotated around the inside of the caisson, together with a vertical dredge pump, was chosen as one method, and heavy-duty clamshell buckets with cutting jets were provided as the other method. The excavation by clamshell bucket, together with a downward force supplied by the air jacks, proved to be the more efficient method.

August 10—that fateful date—arrived with the caissons in various stages of sinking, but none concreted, and the tower was in the direct path of the "big blow." The first swells from Hurricane "Connie" began to build up. Fortunately "Connie" swerved inland. By the end of August, the caissons were secured by welding, the lower ends concreted, and Texas Tower No. 2 was safe.

When the load of the tower had been transferred to the permanent caissons, the temporary caissons became more of a menace than a help, since the wave forces against them were transmitted to the tower. To remove them expeditiously, the temporary brackets were first burned free from the tower, then jacked down by the air jacks to a predetermined elevation. Whereupon the air jacks were removed, the upper end of the caissons made watertight (the lower ends were already blanked off), and each bracket with its two caissons was allowed to fall into the sea and then towed ashore.

Fleet and labor force

Logistic support of the project called for the use of two ocean-going tow boats and two barges 200 ft long, which comprised the fleet. Charter of other vessels was necessary for short periods. The barges were equipped with large mooring engines and quarters for a small crew. One of the towboats was altered to carry up to 40 men. Walkie-talkies for conversation between barges, towboats and the tower were used, while ship-to-shore radio telephones were provided for all vessels and the tower. It required a complicated mooring system with heavy anchors and long anchor lines to moor a barge close enough to the tower so that the cranes could reach the cargoes.

Erection and outfitting of the deckhouse ends, and erection of the center Arctic Radome Tower, were involved undertakings. Included were connections through bulkheads and decks for ducts, piping and wireways; installation of all types of equipment; thermostatic controls; insulation and painting inside, and painting of the entire outside of the tower. More than 12 mechanical and electrical trades were required. The Arctic Tower is a bolted structure 28 ft high, made up of eight thousand pieces. It was assembled on shore, taken apart in four sections, and reassembled on the platform at sea.

With 90 to 100 men on the tower working two 12-hour shifts, seven days a week, the feeding and care of the labor force was a vital problem. Prohibition was back in force from the time the men left shore. The care of job injuries warranted the presence of a physician on the tower at all times.

The spectacular part of the project was the offshore work at the tower. This achievement was made possible by the 24-hour service of the men at the shore bases.

The first installation of its kind, Texas Tower No. 2 is completed. It is a self-sustaining home for 70 officers and men of the Air Force and stands as a sentinel for the defense of the United States. So far as is known, it is the largest structure ever installed so high above the sea, so far from land, and under such hazardous wave and current conditions.

Texas Tower No. 2 was built by the Bethlehem Steel Ship Building Company under a contract with the Bureau of Yards and Docks. It was towed and erected by Raymond-DeLong, a joint venture between Raymond Concrete Pile Company and the DeLong Corporation. The joint venture was directed by George F. Tait, for DeLong Corp., and Gordon F. A. Fletcher, M. ASCE, for Raymond Concrete Pile Company. Construction manager was James D. Bush, Jr.; general superintendent, George Bauer; and shore-base superintendent, Charles Erskine.

Capt. J. J. Albers, CEC (USN) was contracting officer for the entire project. The architect-engineer group consisted of Anderson-Nichols of Boston, Mass., and Moran, Proctor, Muesser & Rutledge of New York, N.Y.

ENGINEERS' NOTEBOOK

Direct design of two-hinged arches of constant section

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Arches with two hinges have been used in the past in both building and bridge construction, but the development of other structural forms during the past twenty or thirty years brought about a decline in the use of such arches, particularly in buildings. In the last few years, however, interest in two-hinged arches has been stimulated by several noteworthy designs. An example is the University of Wyoming Field House, in which the arch ribs of 221-ft span consist of a standard wide-flange section of steel. (See "Steel Arch Analyzed and Designed by Semigraphical Methods," by Milo S. Ketchum, CIVIL ENGINEERING, August 1952, p. 31.) In this type of construction there are advantages, resulting from simplicity of fabrication and erection, that will appeal to designers.

Influence lines for use in the direct design of two-hinged arches of constant section are here presented, for both vertical and horizontal loading on parabolic and on circular arches. To illustrate the use of these influence lines for quick, direct design, a numerical example is included.

A two-hinged circular arch that can be moved horizontally at one end is shown in Fig. 1. From a consideration of Müller-Breslau's influence-line principle, it follows that if a unit horizontal displacement is produced at the support, the vertical displacements of the rib are equal to the influence values for horizontal reaction due to vertical loads, whereas the horizontal displacements are equal to the influence values for horizontal reaction due to horizontal loads.

If the support in Fig. 1 is displaced a small distance horizontally by a force R, the vertical displacement, δ_y, and the horizontal displacement, δ_x, of any point D can be expressed as follows:

$$\delta_y = \frac{Rr^2}{EI}\left[(\cos\phi - \cos\theta_D)\int_{\theta=\phi}^{\theta=\frac{\pi}{2}} \times (\sin\theta - \sin\phi)\,ds - \int_{\theta=\phi}^{\theta=\theta_D} \times (\sin\theta - \sin\phi)(\cos\theta - \cos\theta_D)\,ds\right] \quad \ldots (1)$$

$$\delta_x = 1 - \frac{Rr^2}{EI}\left[(\sin\theta_D - \sin\phi) \times \int_{\theta=\phi}^{\theta=\frac{\pi}{2}} (\sin\theta - \sin\phi)\,ds - \int_{\theta=\phi}^{\theta=\theta_D} \times (\sin\theta - \sin\phi)(\sin\theta_D - \sin\theta)\,ds\right] \quad \ldots (2)$$

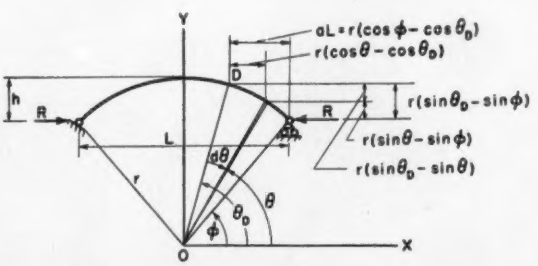
A two-hinged, parabolic arch that can be moved horizontally at one end is shown in Fig. 2. The vertical and horizontal displacements of a point D can be written as follows:

$$\delta_y = \frac{R}{EI}\left[aL\int_{x=0}^{x=\frac{L}{2}} y\,ds - \int_{x=\frac{L}{2}-aL}^{x=\frac{L}{2}} y\left(x + aL - \frac{L}{2}\right)ds\right] \quad \ldots (3)$$

$$\delta_x = 1 - \frac{R}{EI}\left[4\,ha\,(1-a) \times \int_{x=0}^{x=\frac{L}{2}} y\,ds - \int_{x=\frac{L}{2}-aL}^{x=\frac{L}{2}} \times \{4\,ha(1-a) - y\}\,y\,ds\right] \quad \ldots (4)$$

If, in Eqs. 1, 2, 3, and 4, the value of R is such that a unit horizontal movement is produced at the support, the displacements δ_y and δ_x will represent influence values for the horizontal reaction H in a two-hinged arch. The values δ_y will correspond to influence values due to vertical loading, and the values δ_x will correspond to influence values due to horizontal loading.

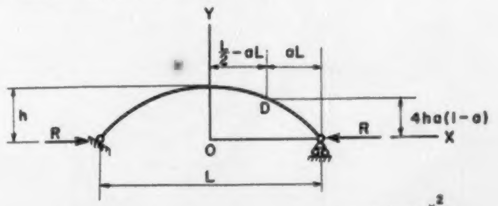
Such expressions for R were substituted in the equations for δ_y and δ_x.



$\frac{h}{L}$ is related to ϕ as follows:

$$\left[1 + 4\left(\frac{h}{L}\right)^2\right]\sin^2\phi - 2\sin\phi + 1 - 4\left(\frac{h}{L}\right)^2 = 0$$

FIG. 1. Two-hinged circular arch that can be moved horizontally at one end.



$$y = h\left(1 - 4\frac{x^2}{L^2}\right)$$

FIG. 2. Two-hinged parabolic arch that can be moved horizontally at one end.

The integrations were performed, and the influence ordinates were then evaluated by Dixon and Bailey. (See "Influence Lines for the Design of Two-Hinged Arches," by Joseph H. Dixon, Jr., a thesis submitted to the Graduate Faculty, Iowa State College, Ames, Iowa, in 1950, in partial fulfillment of requirements for Master of Science degree; and "Direct Design Procedure for Two-Hinged Arches of Constant Section," by Stanley Carl Bailey, a thesis submitted to the Graduate Faculty, Iowa State College, Ames, Iowa, in 1953, in partial fulfillment of requirements for Master of Science degree.)

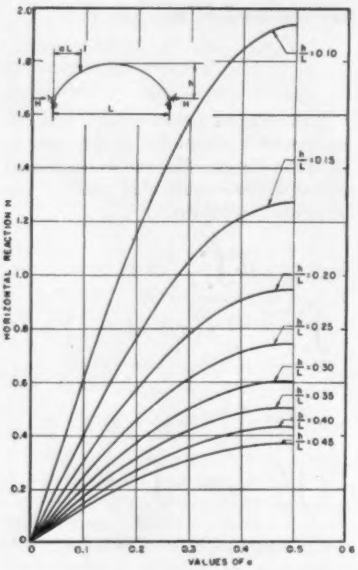


FIG. 3. Influence lines for horizontal reaction in circular arches of constant section—vertical loading.

Influence values for the horizontal reaction H, due to unit vertical or horizontal load, are given in Table I for a load at any one-tenth point of the span in arches having rise-to-span ratios, h/L, of 0.10 to 0.45. For vertical loading, the horizontal reactions are the same at both ends. The values tabulated for horizontal loading are those for the end nearest the load. The influence value at the opposite end is equal to one minus the tabulated value.

Influence values have also been computed for several semi-elliptical ribs, but it was not considered particularly worth while to prepare full sets of values for inclusion here.

In Figs. 3 and 4, influence lines for horizontal reaction due to vertical load on circular and parabolic arches were drawn using the values in Table I. As presented, these curves are not too satisfactory for relatively flat arches with values of h/L other than those plotted. However, this shortcoming can be overcome by using values from the curves in Figs. 3 and 4 to plot other curves such as those shown in Figs. 5 and 6. In the latter figures, curves are shown for five load positions. Obviously, curves similar to these can be drawn quickly for any load positions.

Influence lines for horizontal reaction due to horizontal loading on circular and parabolic arches are shown in Figs. 7 and 8 respectively. Curves comparable to those in Figs. 5 and 6 can also be plotted from Figs. 7 and 8 but are hardly necessary since interpolation is quite satisfactory in the latter figures.

A simple, direct procedure for the design of two-hinged arches of constant section is now considered. The selection of materials, type of section and spacing of arches, and type of roof would be made on the basis of factors, economic and otherwise, not within the scope of this article. In passing, however, it is worth mentioning that one of the advantages of the design procedure discussed here is that, through a reduction and simplification of the labor of analysis, it indirectly puts more emphasis on the overall planning of the structure.

A sketch of the arch framing used in the new University of Wyoming Field House is shown in Fig. 9 (a). The design loads applied at the purlin points are given in (b) and (c) of the same figure. The numerical value of a in the horizontal distance relationship, aL, was determined for each purlin from the properties of the circle, and the curves in Fig. 10 were then drawn from cross-plots of the curves in Fig. 3. Because of the ease with which interpolations can be made in Fig. 7, influence values for horizontal component of load were obtained directly from this figure.

Values of the horizontal reaction, H, for unit vertical and horizontal loads applied at the various purlin positions, were read from Figs. 10 and 7 respectively, and entered in Tables II and III respectively, under the columns labeled "H/kip." These values were then multiplied by the appropriate loads to obtain the horizontal reaction for the actual loading.

Since for vertical loads, the value of H for a load placed to the left of the arch

FIG. 4. Influence lines for horizontal reaction in parabolic arches of constant section—vertical loading.

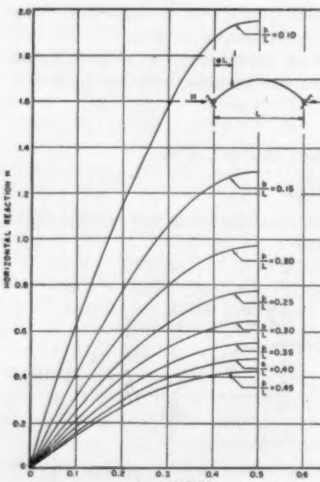


FIG. 5. Influence ordinates for horizontal reaction in circular arches of constant section—vertical loading.

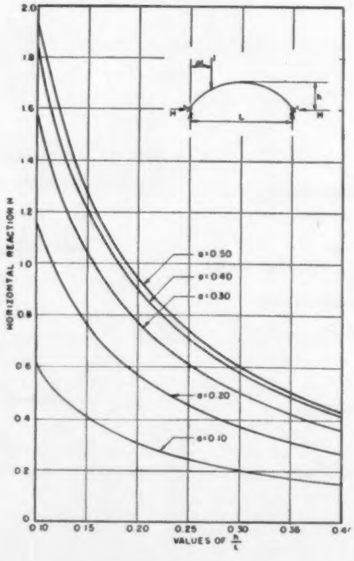


FIG. 6. Influence ordinates for horizontal reaction in parabolic arches of constant section—vertical loading.

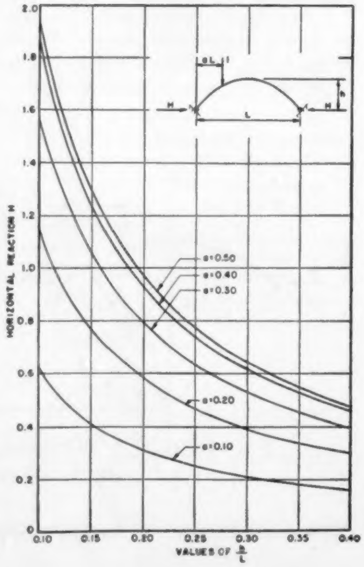


TABLE I. Influence values for horizontal reaction H

h/L	Load Position	Vertical Loading: Circular Arch	Vertical Loading: Parabolic Arch	Horizontal Loading: Circular Arch	Horizontal Loading: Parabolic Arch
0.10	0.1L	0.612410	0.624221	0.773167	0.780167
	0.2	1.156326	1.147421	0.620467	0.625093
	0.3	1.578969	1.574625	0.535858	0.538373
	0.4	1.845689	1.873460	0.504432	0.504941
	0.5	1.936745	1.950550	0.500000	0.500000
0.15	0.1L	0.408372	0.411693	0.765906	0.777317
	0.2	0.767511	0.775963	0.614877	0.623625
	0.3	1.044536	1.058243	0.534487	0.537981
	0.4	1.218516	1.236057	0.504162	0.504828
	0.5	1.277619	1.296660	0.500000	0.500000
0.20	0.1L	0.305822	0.310474	0.755796	0.776189
	0.2	0.571975	0.583648	0.607572	0.622513
	0.3	0.775268	0.793856	0.531769	0.537469
	0.4	0.901475	0.925439	0.503957	0.504770
	0.5	0.944375	0.970160	0.500000	0.500000
0.25	0.1L	0.244027	0.249859	0.742342	0.774844
	0.2	0.453371	0.463058	0.598770	0.621772
	0.3	0.611110	0.635025	0.528636	0.536858
	0.4	0.708602	0.738635	0.503524	0.504668
	0.5	0.741536	0.773686	0.500000	0.500000
0.30	0.1L	0.202450	0.209530	0.725815	0.773373
	0.2	0.373122	0.391540	0.589163	0.619752
	0.3	0.500064	0.529157	0.525411	0.536188
	0.4	0.577913	0.613917	0.503110	0.504516
	0.5	0.604118	0.642448	0.500000	0.500000
0.35	0.1L	0.172280	0.180785	0.706613	0.771893
	0.2	0.314648	0.336761	0.579220	0.618227
	0.3	0.419215	0.453555	0.522246	0.535478
	0.4	0.482877	0.524813	0.502701	0.504409
	0.5	0.504243	0.548649	0.500000	0.500000
0.40	0.1L	0.149072	0.159217	0.685544	0.770368
	0.2	0.269655	0.295692	0.569497	0.616703
	0.3	0.357230	0.396854	0.519303	0.534743
	0.4	0.410278	0.457945	0.502337	0.504323
	0.5	0.427963	0.478236	0.500000	0.500000
0.45	0.1L	0.130342	0.142428	0.663727	0.768902
	0.2	0.233618	0.263740	0.560356	0.615193
	0.3	0.307864	0.352769	0.516642	0.534016
	0.4	0.352603	0.405948	0.502005	0.504220
	0.5	0.367538	0.423488	0.500000	0.500000

TABLE II. Horizontal reactions due to loading in Fig. 9(b)

a	Loads in Kips: Left of Center	Loads in Kips: Right of Center	Total Load	H/kip	H
0.075	11.6	19.5	31.1	0.260	8.1
0.145	10.8	18.2	29.0	0.490	14.2
0.221	10.8	18.2	29.0	0.708	20.6
0.300	10.8	18.2	29.0	0.885	25.7
0.377	11.7	18.2	29.9	1.005	30.7
0.459	17.3	18.2	35.5	1.060	37.6
				Total kips	136.9

TABLE III. Horizontal reactions due to loading in Fig. 9(c)

a	Load	Hor. Comp.	Vert. Comp.	H/kip (Hor. Comp.)	H/kip (Vert. Comp.)	H for Hor. Comp.	H for Vert. Comp.
0.075	2.6	1.390	2.20	0.813	0.260	1.130	0.572
0.145	2.5	1.118	2.24	0.682	0.490	0.763	1.099
0.221	1.6	0.560	1.50	0.589	0.708	0.330	1.061
0.300	4.4	−1.110	−4.26	0.533	0.885	−0.592	− 3.770
0.377	5.4	−0.836	−5.34	0.507	1.005	−0.424	− 5.360
0.459	5.4	−0.283	−5.39	0.501	1.060	−0.142	− 5.720
0.541	5.4	0.283	−5.39	0.499	1.060	0.142	− 5.720
0.623	5.4	0.836	−5.34	0.493	1.005	0.412	− 5.360
0.700	5.4	1.361	−5.23	0.467	0.885	0.636	− 4.630
0.779	4.5	1.578	−4.22	0.411	0.708	0.650	− 2.990
0.855	4.4	1.965	−3.94	0.318	0.490	0.625	− 1.930
0.925	4.7	2.510	−3.98	0.187	0.260	0.470	− 1.035
Total kips		9.372				4.000	−33.784

At left end: $H = 33.784 + 4.000 = 37.784$ kips (←)

At right end: $H = 33.784 - (9.372 - 4.000) = 28.412$ kips (→)

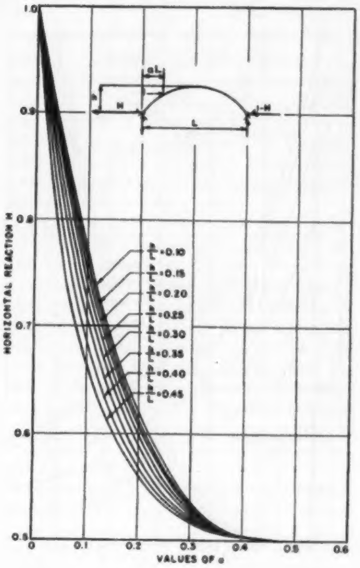


FIG. 7. Influence lines for horizontal reaction in circular arches of constant section — horizontal loading.

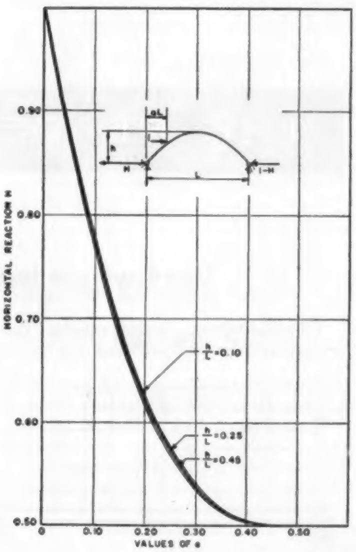


FIG. 8. Influence lines for horizontal reaction in parabolic arches of constant section — horizontal loading.

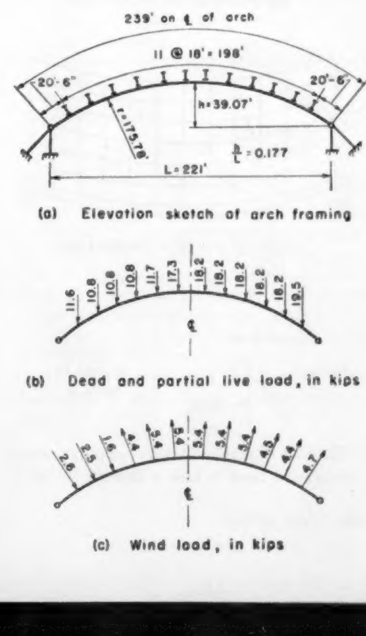


FIG. 9. Arch dimensions and loads.

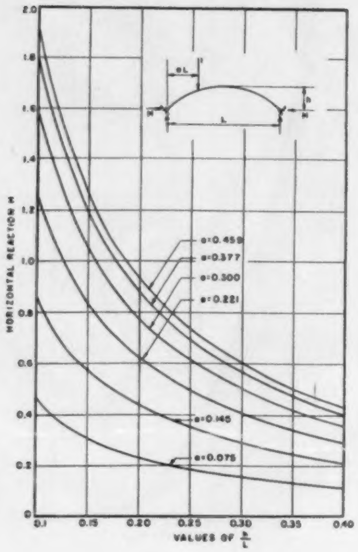


FIG. 10. Influence ordinates for arch of Fig. 9—vertical loading.

crown is equal to the value of H obtained when the load is placed the same distance to the right of the crown, it was convenient in Table II to add symmetrically placed loads and then multiply each sum by the appropriate influence value. The sum of these products, or 136.9 kips, is the horizontal thrust at each end due to the loading shown in Fig. 9 (*b*).

In Table III the loads given in Fig. 9 (*c*) were resolved into vertical and horizontal components. The minus signs indicate horizontal loading to the left or vertical loading upward. The horizontal and vertical components of load are multiplied by the appropriate influence values, listed under the heading H/kip, to obtain the horizontal reactions of -33.784 kips at both supports due to vertical loading, and of 4.000 kips at the left support due to horizontal loading. The minus sign in front of the value 33.784 indicates that the horizontal reactions due to the vertical components of load are opposite to those in Fig. 10, that is, they are applied outwardly. The positive sense of the value 4.000 indicates that the horizontal reaction at the left end due to the horizontal components of load is applied outwardly, as in Fig. 8.

At the right end the horizontal reaction due to the horizontal components of load is equal to the difference between the sum of the horizontal components, 9.372, and the reaction at the left end, 4.000, or 5.372 kips inwardly. The final reactions for the loading shown in Fig. 9 (*c*) are then 37.784 kips at the left end and 28.412 kips at the right end, both applied outwardly.

THE READERS WRITE

Dead-weight loading of test beams

To the Editor: In their article, "Pretensioning Wires in Test Beam Curved by Simple Device" (October issue, p. 113), authors Crissey and Mantell showed a device for applying additional tension to wires already pretensioned.

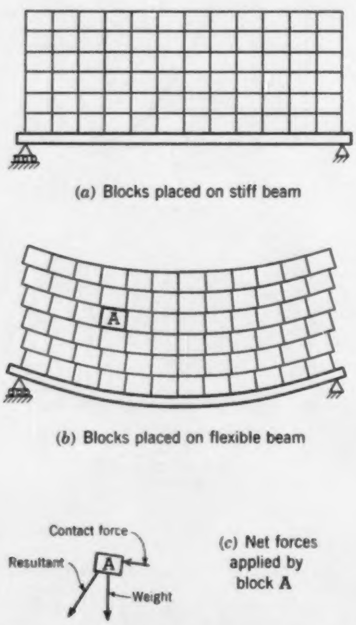


FIG. 1. Arching action occurs when blocks are used to load a flexible beam.

It appears from the discussion and from the photograph that the test beam was loaded by placing concrete blocks in continuous courses—that is, blocks laid end to end with ends touching, or nearly touching. Unfortunately, such a system of loading a test beam completely invalidates the test, because an arching action, similar to arching in soils, is induced in the blocks which transfers their weight from the beam onto the supports. It is quite possible that only half the weight of the blocks is actually acting on the beam. This arching action can also be observed when sand bags are used for weights.

The mechanics of the arching action is illustrated in Fig. 1. If the beam is very stiff, as in Fig. 1 (*a*), there is little readjustment in the position of the blocks, and the weight of the blocks is transferred to the beam directly below. If the beam is flexible—as all beams are in varying degree—the beam sags as shown in Fig. 1(*b*), and a readjustment in the position of the blocks takes place. The net forces acting on an individual block are shown in Fig. 1(*c*). The resultant of this force system is a diagonal force directed toward one of the supports; it is not directed directly downward onto the beam.

In order to load test beams with dead weights it is of the utmost importance to stack the dead weights in several piles so that no pile touches any other.

The question raised as to the validity of the test of the beam does not detract from the credit due to the authors for developing this ingenious device. If the writer has misinterpreted the photograph, this discussion may at least serve as a warning to those who may in future perform similar tests.

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Constructive criticism needed in education

To the Editor: With much interest I have been following the various letters on engineering education in this column. There appear to be two main thoughts: that the schools have done and are doing a pretty fine job, considering the limitations imposed from various sources; and that broad judgment and basic understanding can be obtained only through long experience and hard work.

With the first of these, I have little argument. For the great number of devoted and hard-working educators I have the utmost respect and admiration. But they are also human, usually conservative, and frequently susceptible to academic inbreeding. If, in today's rapidly changing environment, we are to keep our sights ahead, rather than backward, I do *not* believe that sincere, constructive criticism is out of order.

As to the second—that schooling cannot replace experience—it is a matter of

degree, not one of absolutes. John B. Wilbur, M. ASCE, covers this most admirably in his article, "The Paradox of Professionalism" (November 1955 issue, p. 56), in which he points out the danger of inhibiting the development of judgment and imagination.

In Mr. d'Errico's letter (November issue, p. 62), two statements seem to constitute rather serious indictments of the educational system. One, "Maturity and judgment are not developed in the classroom, but only by experience on the job." The other, "Whether a person is to be a technician or an engineer depends only on that person." Again, a matter of degree?

In the same letter the question is raised as to how a curriculum can be revised to develop broad thinking and basic understanding. This is, of course, the very meat of the problem. The following suggestions are offered, not as being applicable to wholesale production of engineers but rather to a selected group of students. (Technicians can be turned out wholesale, but engineers can't.) The selection would be based on above-average intelligence, proven ability to grasp underlying concepts and principles, and an inclination to question rather than to accept blindly.

First, we should correct a frequently misplaced emphasis on precision. This does not mean encouragement of sloppy habits or reduced emphasis on accuracy. The distinction between accuracy and precision is not always too clearly recognized. Precision has its place, and a very important place, in the application of engineering techniques, but undue stress on it may inhibit understanding and appreciation of broad principles.

Second, more emphasis should be placed on basic principles, together with practice in the application of those principles to thought-provoking, real-life situations. Along with this would be acquisition of a general knowledge of available related techniques—rather than spending considerable time acquiring skill in the application of these techniques, most of which the student will never again be called upon to use.

Third, what about our teaching staffs? Certainly this is no attempt to belittle the contributions made by the many devoted (and often poorly paid) members of the teaching profession. The fault is not with individuals, but with the system. The exceptional student continues on to receive higher academic degrees, usually by rather narrow specialization, and proceeds from there to teaching. Under these conditions, it is only natural for him to teach a subject as an isolated segment of organized knowledge academically insulated from the outside world. The obvious answer would seem to be more interplay between the cloistered halls of learning and the engineering community. The general interest evidenced in the pages of CIVIL ENGINEERING is indeed a healthy sign.

HERMAN L. DANFORTH, M. ASCE
City Engineer
City of Rockford, Ill.

Meager data for "plastic" design of concrete

TO THE EDITOR: Professor Ernst's article, "Plastic and Ultimate Load Theory Should Be Included in Teaching of Structural Analysis" (September issue, p. 36), has been read with interest.

The important question regarding the application of plastic and ultimate load theories to reinforced concrete is not one of their economy in comparison with the elastic theory but is a much more serious one. Are they applicable at all? Is concrete under short-time loading plastic or is it as unyielding and brittle as it was long believed to be?

There can be no question as to the slow long-time plasticity of concrete. In 1934, Professor Sergev's paper, "Deformation of Steel Reinforcement During and After Construction" (*Transactions* of ASCE, Vol. 99, p. 1343), reported stress changes in columns and beams in the then newly erected Physics Building at the University of Washington, Seattle. He established gage marks on column and beam reinforcement before any concrete was placed around them; then, for the following 840 days he read deformations and converted them to stresses. Observed compression in column verticals in 1:1:2 concrete increased from 5,500 psi to 25,500 psi. Observed tensile stresses at midspan of $1:2^1/_4:3^3/_4$ beams attained a maximum value of 11,000 psi, then gradually decreased to about 700 psi. Since these bars were embedded in and bonded to the concrete, change of stress in the bars was only to be attributed to shrinkage, creep, and plastic flow in the concrete.

But when sudden, abrupt, short-time plasticity of concrete is postulated in the flexural theories of Whitney, Jensen, Hognestad et al., what is the physical basis of it? There really appears to be little or none. Whitney refers to cylinders tested by two students at the University of Wisconsin whose stress-strain results can be duplicated but whose findings in the "plastic range" failed to include mention of the shattered and fragmented condition of the concrete. (See the writer's article, "When Concrete Becomes Discrete," in CIVIL ENGINEERING for April 1950, p. 29, and correction, May 1950, p. 49). Jensen develops his theory by combining stress-strain evidence of "the elastic range"—which is irreproachable—with the Saliger speculation shown in curve *X*, Fig. 1 (above reference, May 1950), which cannot be duplicated.

More recently Hognestad presented a similar "plastic" theory ("Inelastic Behavior in Tests of Eccentrically Loaded Short Reinforced Concrete Columns," *Journal of ACI*, Oct. 1952, p. 117). This theory is founded on three stress-strain curves titled "Test of 3 × 6 Cylinders (Bureau of Reclamation)." It must be evident to everyone that these are meager data for which to abandon the widely used straight-line theory of design and substitute a "plastic" theory. No information was given as to the mix of concrete, number of cylinders, age at test, etc., but smooth, continuous, unbroken—and unannotated—curves peaking at strains of 0.002 and descending in typical form to strains of 0.009 or more, coupled with the honored name of the Bureau of Reclamation, undoubtedly seemed convincing and sufficient to the average reader.

However, the writer sought out the original of these curves, found them in the Bureau's Laboratory Report No. SP-12, March 17, 1947, Fig. 8, and there learned that "each curve represents the loading of a single 3-in. × 6-in. cylinder under no restraint. Loading time for ages 9 and 13 days was 15 minutes. Loading time for age 41 days was 50 minutes." Perhaps this is to be regarded as but characteristic of the typical "plastic" foundation of "plastic" theory. The writer prefers one somewhat firmer.

Incidentally be it told that Figs. 4 and 5 of this same laboratory report, showing "the condition of cylinders which have been strained about 0.009 inch per inch," reveal the same shattering and fragmentation found in the writer's "discrete" specimens. The question is: Where is the plasticity?

Professor Ernst would be well advised, if his rigid frame is of reinforced concrete, to use the straight-line or elastic theory in its design.

HOMER M. HADLEY, M. ASCE
Hadley & Hadley, Consulting Engineers
Seattle, Wash.

Tabular solution for circular segment areas

TO THE EDITOR: As regards the solution in the article, "Circular Arcs and Circular Segements Calculated," by John L. Nagle, M. ASCE (June issue, p. 61), discussions by Prof. T. F. Hickerson, M. ASCE (August issue, p. 65), and by Francis Bates, M. ASCE (October issue, p. 114), tabular values are obligatory for the sine and, since most tables furnish circular measure in degrees and minutes, why introduce a constant for an item that can be picked out of a table?

Repeating Professor Hickerson's two equations:

$$\text{Length of arc} = R\theta \qquad (1)$$

$$\text{Area of Segment} = \frac{R^2}{2}(\theta - \sin\theta) \qquad (2)$$

For Eq. 1, the quickest solution is tabular. For Eq. 2, again, the quickest solution is tabular, with the added incentive that the value of the parenthesis is not too sensitive to slight changes in the angle; in other words, in most cases, seconds may be omitted. Furthermore, Eq. 2 is correct in any quadrant if the proper quadrant sign be given to the tabular value of sin θ.

JOHN ORTH COOK, M. ASCE
Pittsburgh, Pa.

SOCIETY NEWS

Dallas Convention Offers Notable Program

An unusual program has been lined up for the information and entertainment of engineers attending the Society's Dallas Convention, February 13–17. What's more visitors are being led to expect "comfortable, even spring-like temperatures" while stay-at-homes in most parts of the country will be enduring winter at its worst. Attendance at the Convention is expected to exceed 1,400, according to I. W. Santry, Jr., associate professor of civil engineering at Southern Methodist University and general Convention chairman.

The eighty-odd technical papers being readied for presentation during the Convention include such innovations as a symposium on plastics as a building material and in other engineering uses. The Engineering Mechanics Division is sponsoring the plastics session, the first comprehensive discussion of its kind ever held at an ASCE gathering. Contributors include Walter Tiedeman, director of the National Sanitation Foundation laboratory at Ann Arbor, Mich., who will deal with plastics in water supply; Albert G. H. Dietz, professor of building engineering and construction at Massachusetts Institute of Technology, who will cover plastics in buildings; Gordon M. Kline, chief of the Organic Materials Division of the National Bureau of Standards, who will explain the different classes of plastic materials; and C. Howard Adams, of the Plastics Division of the Monsanto Chemical Co., Springfield, Mass., whose subject is "Plastics—Engineering Materials."

To think of Texas these days is to think of pipelines. And so the Construction Division's new but highly active Pipeline Committee is sponsoring three special sessions and a luncheon during the Convention. Principal speaker at the luncheon will be Rear Admiral L. B. Combs, head of the civil engineering department at Rensselaer Polytechnic Institute. One of the Pipeline Committee sessions will feature a talk by Stephen D. Bechtel, Jr., vice-president of the Bechtel Corp., whose subject is "Civil Engineering in Pipelining." Also scheduled to be heard at this session are S. J. Helfman, chief utility engineer of Barnard and Burk, consulting engineers of Baton Rouge, La., and Paul Herzig, vice-president of the Houston Gas and Oil Corp.

Offshore pipeline installations will occupy another session, the speakers to include Donald M. Taylor, editor of "Pipeline Industry," Gulf Publishing Co., Houston; Clyde Aldridge, Magnolia Pipeline Co., Dallas; and S. V. Collins, Collins Construction Co., Port Lavaca, Tex.

Papers comprising still another pipeline program will be on "Application of a Magnetic Drum Electronic Computer to Pipeline Design," by Harold E. Thomas, Pipeline Design Section, El Paso Natural Gas Co.; "Photogrammetry in Pipeline Engineering," by Marshall S. Wright, Jr., engineering consultant for Jack Ammann Photogrammetric Engineers, Inc., San Antonio, Tex.; "Underground Storage of Gas in Relation to Pipeline Operations," by John Viglini, assistant chief engineer, Transmission Division, Lone Star Cement Co., Dallas; and "Maintaining Line Efficiency in Natural Gas Pipelines by Liquid Removal," by A. W. Rifenburgh, Mississippi Fuel Corp., St. Louis, Mo.

To supplement these sessions, the Pipeline Committee has also planned a tour of interesting pipeline installations and facilities in the Dallas area.

Tours of three other construction projects will also be offered on an informal basis through arrangement with the Convention committee. The objectives of these trips will be the $7,000,000 Dallas Memorial Auditorium, a large rigid-frame structure that will provide seating capacity for 10,000 in one unobstructed arena; the Dallas-Fort Worth Toll Road still in a preliminary stage; and the Turtle

This composite photo-illustration shows how the new Dallas Memorial Auditorium (in the foreground) will look when completed. Now under construction, the $7,000,000 rigid-frame structure will be the objective of one of the Dallas Convention tours. The auditorium will have seating capacity for 10,000 in one unobstructed arena.

Creek Pressure Sewer Project, which is being built by the Corps of Engineers. The latter project is notable for its exceptionally large diameter and for problems resulting from a number of special railroad crossings involved.

Right-of-way acquisition for the toll road will be discussed at a Highway Division luncheon by J. C. Dingwall, manager and executive secretary of the Texas Toll Road Authority. A Structural Division session will be devoted to design and construction of the Dallas Memorial Auditorium, with speakers to include Boyd G. Anderson, partner in the New York consulting firm of Ammann & Whitney; Henry Shepard, vice-president and chief of the Heavy Construction Division of R. P. Farnsworth & Co., Inc., New Orleans; and H. P. Farnsworth, Jr., director, general superintendent, and project coordinator of field construction for the Farnsworth Co.

Guaranteeing a wide variety of technical papers are other sessions scheduled by the Air Transport, Hydraulics, Waterways, Highway, Power, Sanitary Engineering, Surveying and Mapping, Soil Mechanics and Foundations, and Irrigation and Drainage Divisions.

A special program on professional development will be sponsored by the popular Department of Conditions of Practice. A panel of experts will discuss the development of professional aims and attitudes in the legal and medical professions as well as the position of ASCE members in this respect. At another Conditions of Practice session the talk will be of Local Sections and Branches and the extent to which they may participate as a unit in political activities.

Delegates to the Local Section Conference are expected from as far away as Brazil, Panama, Puerto Rico, Venezuela, and Mexico as well as from Sections in the South and Southwest. There will also be a Conference of Faculty Advisers from ASCE Student Chapters in the Southwest and a Student Chapter Conference, which will feature a student paper contest sponsored by the Texas Section.

Highlights of the social program include a general membership luncheon, with Allan Shivers, governor of Texas, the featured speaker; a Western ranch-style party featuring a fiesta and other regional entertainment; and the more traditional dinner dance. For the ladies there will be, in addition, a brunch and style show at Neiman-Marcus Co., a specialty store nationally famous for high fashion; a tour and tea at the Republic National Bank Building; and a special luncheon.

Dallas' new Turtle Creek Pressure Sewer, a Corps of Engineers project, is notable for its large diameter and the number of special railroad crossings involved. It is one of the projects on tour for Dallas Convention visitors.

Board Confirms New Committee Personnel

The Board of Direction, at its meetings in New York in October, confirmed appointment of ASCE committees for the coming year. The committees of the Board follow (all terms expire October 1956).

Executive Committee: Enoch R. Needles, Chairman; Louis R. Howson, Vice-Chairman; Wm. Roy Glidden. Glenn W. Holcomb, Frank A. Marston, Daniel V. Terrell, and Frank L. Weaver.

Honorary Membership: Enoch R. Needles, Chairman· Louis R. Howson, Vice-Chairman; Wm. Roy Glidden, Glenn W. Holcomb, Frank A. Marston, Daniel V. Terrell, and Frank L. Weaver.

Districts and Zones: Louis R. Howson, Chairman; Frank A. Marston, Vice-Chairman; Glenn W. Holcomb, and Frank L. Weaver.

Professional Conduct: George S. Richardson, Chairman; Jewell M. Garrelts, Vice-Chairman; L. A. Elsener, Samuel B. Morris, Frederick H. Paulson, and Robert H. Sherlock.

Meetings: Louis R. Howson, Chairman; Frank A. Marston, Vice-Chairman; Glenn W. Holcomb, and Frank L. Weaver.

Publications: Samuel B. Morris, Chairman; Jewell M. Garrelts, Vice-Chairman; Ernest W. Carlton, Mason C. Prichard, R. Robinson Rowe, and Louis E. Rydell.

Membership Qualifications: William S. LaLonde, Jr., Chairman; Thomas C. Shedd, Jr., Vice-Chairman; Don M. Corbett, Clarence L. Eckel, Oliver W. Hartwell, and Mason C. Prichard.

Division Activities: Louis R. Howson, Chairman; Frank A. Marston, Vice-Chairman; Jewell M. Garrelts, R. Robinson Rowe, Samuel B. Morris, ex-officio (Chmn., Publications Committee), and Martin A. Mason, ex-officio (Chmn., Research Committee).

Conditions of Practice Executive Committee: Frank L. Weaver, Chairman; Glenn W. Holcomb, Vice-Chairman; Ernest W. Carlton, Don C. Corbett, R. F. Dawson, L. A. Elsener, Jewell M. Garrelts, Frederick H. Paulson, Thomas C. Shedd, and G. P. Willoughby.

The Auxiliary Administrative Committees will be

Annual Convention: John P. Riley, Board Contact Member (1956).

Application Classification: Albert Haertlein, Chairman (1956); Wm. J. Shea, Vice-Chairman (1957); Harold L. Blakeslee (1958), and Wm. S. LaLonde, Jr., Contact Member (1956). Alternates: V. T. Boughton (1956) and L. G. Holleran (1956).

Budget (Terms expire October 1956): Frank A. Marston, Chairman; Oliver W. Hartwell, and Wm. J. Shea.

Securities (Terms expire October 1956): Allan R. Cullimore, Chairman; George W. Burpee, and John P. Riley.

The new Professional Committees are:

Junior Members: Hamilton Gray, Chairman (1956); Finley B. Laverty, Vice-Chairman (1958); James M. Morgan, Jr. (1957), Frank W. Edwards (1959), and Ernest W. Carlton, Contact Member (1956).

Local Sections: Frank C. Mirgain, Chairman (1956); Elmer J. Maggi, Vice-

Chairman (1958); Wm. J. Shea (1957), C. E. Drummond (1959), and F. H. Paulson, Contact Member (1956).

Student Chapters: Clifford D. Williams, Chairman (1956); C. Russell Dole, Vice-Chairman (1957); Charles E. Clarridge (1958), Emory E. Johnson (1959), Lauress L. Wise (1960), and Raymond F. Dawson, Contact Member (1956).

Registration of Engineers: Wm. M. Spann, Chairman (1957); David G. Baillie, Vice-Chairman (1958); Harold E. Wessman (1956), Daniel C. Walser (1959), and Don C. Corbett, Contact Member (1956).

Salaries: Oscar S. Bray, Chairman (1956); Don H. Mattern, Vice-Chairman (1958); Dewitt C. Greer (1957), Warren H. Parks (1959), and G. P. Willoughby, Contact Member (1956).

Employment Conditions: Charles W. Yoder, Chairman (1956); Jack Y. Long, Vice-Chairman (1958); Herbert F. Darling (1957), Charles W. Griffin, Jr. (1959), and L. A. Elsener, Contact Member (1956).

Engineering Education: Edwin H. Gaylord, Chairman (1959); Roland P. Davis, Vice-Chairman (1958); Harry A. Williams (1956), Weston S. Evans (1957), and Thomas C. Shedd, Contact Member (1956).

Professional Practice: *Karl R. Kennison, Chairman (1957); Herbert C. Gee, Vice-Chairman (1958); Raymond A. Hill (1956), *Lloyd D. Knapp (1959), and *J. M. Garrelts, Contact Member (1956).

Appointments to the Technical Committees are as follows:

Research: Martin A. Mason, Chairman (1958); Robert E. Stiemke (1956), Lowell E. Gregg (1957), Elmer K. Timby (1959), and Carey H. Brown, Contact Member (1956).

Technical Procedure (All terms expire October 1956): †Louis R. Howson, Chairman; Frank A. Marston, Vice-Chairman; Jewell M. Garrelts, ‡Martin A. Mason, **Samuel B. Morris, and R. Robinson Rowe. In addition, the committee includes the executive committee chairmen of the Technical Divisions.

New appointments to the Task Committees follow. All terms expire October 1956.

Advisory Committee on EJC Water Policy Panel: Louis R. Howson, Chairman; W. L. Chadwick, Vice-Chairman; Norman R. Moore, George W. McAlpin, I. C. Steele, and M. J. Shelton.

George Washington Memorials: U. S. Grant, III, Chairman; C. G. Paulsen, Co-Chairman; Daniel C. Walser, Frank L. Weaver, and Mason C. Prichard, Contact member.

Committee on Cost Allocation for Multiple-Purpose Water Projects: F. W. Scheidenhelm, Chairman; W. W. Horner, R. J. Tipton, and M. W. Torkelson.

Committee on Engineering Education: Adolph J. Ackerman, Chairman; Harvey O. Banks, Frederick B. Farquharson, Nathan M. Newmark, John B. Wilbur, Kirby Smith, and Carey H. Brown, Contact Member.

Committee on Establishment of Local EJC Groups: L. A. Elsener, Chairman; Don M. Corbett, F. H. Paulson, and G. P. Willoughby.

Committee on Voluntary Fund: Finley B. Laverty, Chairman; Weston S. Evans, Edwin H. Gaylord, Hamilton Gray, and G. P. Willoughby, Contact Member.

Committee on Engineers in Civil Service: C. G. Paulsen, Chairman, and F. L. Weaver.

Committee on Convention Exhibits: Philip C. Rutledge, Chairman; Renville S. Rankin, William S. Foster, Brice R. Smith, and Carey H. Brown, Contact Member.

New appointments to the Joint Committees follow:

ASCE-AGC Joint Cooperative Committee (Terms expire October 1956): C. B. Molineaux, Chairman; Arthur E. Poole, W. W. Wanamaker, and M. C. Prichard, Contact Member.

ASCE-AIA Joint Cooperative Committee (Terms expire October 1956): Wm. O. Hiltabidle, Chairman; Mason G. Lockwood, Craig P. Hazelet, and R. H. Sherlock, Contact Member.

Engineers Council for Professional Development: Harry S. Rogers (1956), Ralph E. Fadum (1957), Harold E. Wessman (1958), and Clarence L. Eckel, Contact Member (1956).

Engineers Joint Council: C. S. Proctor, J. M. Garrelts, L. R. Howson, W. H. Wisely, and Enoch R. Needles (ex-officio). Alternates: J. P. Riley, W. S. LaLonde, Jr., F. H. Paulson, and W. N. Carey.

ASCE-AWWA Committee on Spillways: Francis B. Slichter, Chesley J. Posey, and I. C. Steele.

Engineering Societies Center: Frank A. Marston, Mason G. Lockwood, and Ralph B. Wiley.

United Engineering Trustees: George W. Burpee (1956), C. B. Molineaux (1958), and D. V. Terrell (1959).

John Fritz Medal Board of Award: Carlton S. Proctor (1956), Walter L. Huber (1957), Daniel V. Terrell (1958), and Wm. Roy Glidden (1959). Alternate: Enoch R. Needles (1956).

Washington Award Commission: E. M. Fucik (May 1956) and John F. Seifried (May 1957).

Engineering Foundation: Wm. N. Carey (1956), Elmer K. Timby (1957), and Leslie G. Holleran (1959).

American Association for the Advancement of Science: Thorndike Saville (1957) and Waldo E. Smith (1958).

Hoover Medal Board of Award: Ezra Whitman (May 1956), Malcolm Pirnie (May 1958), Carlton S. Proctor (May 1960), and ***Leslie G. Holleran (May 1962). Alternates: Charles W. Bryan, Jr. (May 1956), Francis S. Friel (May 1958), George W. Burpee (May 1960), and ***R. E. Dougherty (May 1962).

* ASCE-ASME Joint Committee on Professional Practice Manual.
† Chairman, Committee on Division Activities.
‡ Chairman, Committee on Research.
** Chairman, Committee on Publications.
*** Term to begin after 1956 Meeting of Board of Award.

Data for ASCE Membership Directory Requested

The next Membership Directory will be issued in 1956. It will carry address data of record in the Society's files as of March 15, 1956. In order that the Directory may be as complete and useful as possible, all members who have not furnished the headquarters office with up-to-date personal information are urged to do so. The information should include (1) full name, (2) name and address of organization with which associated, (3) title of position with the organization, (4) complete residence address, and (5) indication of mailing address to be used—business or residence.

Postal card requests for reporting changes of address will not be sent to members. Each one will be responsible for supplying information as to change of address or occupation. In order to meet production schedules, changes recorded later than March 15 cannot be carried in the Directory.

For the convenience of members, the coupon on page 116 of this issue may be used.

Copies of the Directory will be available to members of the Society, upon individual request, about July 1. Requests should not be made before June 1.

Board Committee Commends Group Insurance Plan

At the request of President Glidden the Board of Direction at its meeting on June 13 and 14, 1955, appointed a Task Committee to review the benefits of the present ASCE Group Disability Insurance Plan and instructed that the committee submit its report at the October 1955 meeting of the Board of Direction. The Committee, which consisted of M. J. Shelton, chairman, W. S. La Londe, Jr., and George S. Richardson, carried on a study through the interim period. On receipt of the Task Committee's report, the Board reaffirmed the value of the plan and endorsed the findings of the Committee. The following paragraphs are quoted from the Committee's report:

Each committee member made contacts with his personal insurance advisers or insurance representatives and obtained comparative information on the ASCE Plan and other plans which might be obtained by individuals or as group coverage. One member sent a questionnaire to his engineering employees to obtain reactions of Society members. Another committee member contacted the administrator of the Plan and discussed the various questions, with the result that the administrator caused a detailed study to be made. This study is summarized in a brochure dated October 10, 1955, which with the brochure of December 27, 1954, covers the advantages of the ASCE Plan, item by item, as compared with coverage available through individual plans of the Connecticut General Life Insurance Co. and the Security Mutual Life Insurance Co. Recommendations were obtained from "first line" insurance companies doing strictly life insurance work. If they are requested to make available group casualty coverage, as part of a package insurance plan, they as a rule farm out such group casualty insurance to casualty companies. These "first line" insurance companies have indicated that the ASCE Plan is placed with the type of company best prepared to write this type of insurance, and that the coverage and features offered ASCE members are very good.

The members of the committee entered upon the study with a critical mind but have concluded that the ASCE Plan offers the Society membership excellent coverage, and to the best of our knowledge, the best obtainable. We would recommend continuation of the Plan as now constituted.

J. C. Adams, of the Connecticut General Life Insurance Co., has stated the following outstanding advantages of the ASCE Plan over commercial accident and health plans, individually underwritten:

(*a*) Group underwriting is provided.

(*b*) No individual contract will be terminated until retirement or age 70.

(*c*) Contracts cannot be restricted after writing.

(*d*) Health coverage is continued to retirement or age 70.

(*e*) Level premiums over entire period—no increase at age 50 on health coverage.

(*f*) All premiums are the same regardless of the occupational hazard.

In reference to (*c*), it can further be said that contracts remain in force, even though the member changes employment. In reference to (*f*), it may also be said that the rate is based upon "supervising duties only" rather than special risk classifications of the individuals.

ASCE was one of the first societies to make such insurance available to its membership; since then, at least seven other professional societies or associations have done likewise. The form of application is very simple, with few questions as compared to individual plans. There is no physical examination requirement which makes the coverage available to many who otherwise could not obtain such insurance. ASCE pays nothing in making the Plan available to its membership. All mailings of letters informing the membership of the Plan are made at the expense of the administrator.

The Plan has been in effect since August 1, 1949, and increased benefits have been made available, without cost to the insured, as follows:

1. The addition of a second year of health protection.
2. An additional two weeks of partial disability payments.
3. A guaranteed minimum indemnity provision.
4. An extension from five years to lifetime of accident protection provisions.

Also, arrangements were made for a special plan for Junior Members at a lower premium. Negotiations were also completed for doubling the weekly indemnity previously available for those members under age 55, and for an increase from $50 to $75 weekly indemnity for those under age 60, at proportionate rates. A Senior Plan to provide hospital and surgical benefits for those over age 70, was made available on the sixth anniversary, if the member's basic plan had been in force five years. Other additional benefits are under consideration by the administrator at present. Future reviews by task committees with the administrator could likewise result in added benefits.

Smith & Sternau, Inc., administrators of the ASCE Group Insurance Plan, is an agent of record. As such, they are free to continue the administration of the Plan for the Society, regardless of any change of company. As our representative or agent, they can actually use this fact to obtain maximum benefits from the company. We should assure ourselves of this by continuing reviews in the future.

In conclusion, we would say that ASCE has the best plan obtainable at this time, that we stand a better chance of further improvements in the plan by its continuation, and that some serious consideration should be given to more fully acquainting the membership of its many advantages and the advisability of more members taking out such protection.

Freeman Fellowship For 1956 Is Open

Availability of the 1956 Freeman Fellowship for study or research in hydraulics is announced by the Freeman Award Committee. ASME and ASCE are joint administrators of the fund, which was established in 1924 by John R. Freeman, Past-President and Honorary Member of both societies. The committee makes awards through these societies in alternate years. This year the award could total $3,000, depending on the need claimed in the application.

Qualified members of both societies may apply for the fellowship. Applicants must submit a study or research program covering a period of at least nine months beginning in 1956. In addition to furnishing evidence of qualification to carry out the proposed program, candidates must be citizens of the United States. Preference will be given persons working on defense projects.

Applications should be submitted to the Freeman Award Committee, c/o the ASME, 29 West 39th St., New York 18, N.Y., by February 1, 1956. The award winner will be named on March 15, 1956.

Index to 1955 "Civil Engineering" Ready

The index to Volume 25 of CIVIL ENGINEERING will be ready about February 1 and will be available without charge to members wishing to incorporate it in their bound volumes. A postal card request to Society headquarters will suffice.

Single copies of the index are sent to all subscribing libraries. Extra copies are available to libraries on request.

Daniel W. Mead Prizes Given for Essays on Ethics

Merle H. Banta, J.M. ASCE, of St. Louis, Mo., and J. E. Abbott, J.M. ASCE, of San Francisco, are the winners of the 1955 Daniel W. Mead Prizes for the two best papers on an aspect of professional ethics. This year both wrote on the topic, "What Kind of Advertising Should Be Considered as Derogatory to the Engineering Profession?"

Merle H. Banta, winner of the Junior Member Prize consisting of a certificate and cash award of $100, received his professional training at Washington University, St. Louis, where he had a full-tuition honor scholarship. He was honored by the St. Louis Section as the outstanding civil engineer in the 1954 graduating class, and received a graduate fellowship to Iowa State College, graduating in June 1955 with a master of science in structural engineering. Off and on he has been associated with the St. Louis consulting firm of Neal J. Campbell. Currently he is attending the Naval Officer Candidate School at Newport, R.I., and will be commissioned an ensign in the Civil Engineer Corps in March.

Mr. Abbott, a 1955 graduate of the Georgia Institute of Technology and winner of the student prize, is now employed as a junior engineer in the Office of the Chief Engineer of the Western Pacific

Merle H. Banta

J. E. Abbott

Railroad, San Francisco. While at Georgia Tech he spent several cooperative work quarters with the City of Tampa, Fla., and the Louisville & Nashville Railroad. He was active in the ASCE Student Chapter and served as editor of its publicaion. He is a second lieutenant in the U. S. Army Reserve, Ordnance Corps. The student prize consists of $50 in cash and a certificate.

Executive Committee Meets in Atlanta

The Executive Committee of the Board of Direction met in Atlanta, Ga., on December 4. On the previous evening the Committee members were honor guests of the Georgia Section at its 43rd annual dinner. There follows a brief statement of actions taken by the Committee.

Joint Meetings in Toronto

The Toronto Branch of the Engineering Institute of Canada has invited ASCE to cooperate with EIC and the Institution of Civil Engineers (British) in setting up a local joint committee that would arrange and conduct several meetings of civil engineering interest each year in the Toronto area. In accepting the invitation, the Committee authorized an annual appropriation of $100 to be matched by the other two societies, to carry out this activity.

J. Waldo Smth Fellowship Expanded

Beginning in 1957, the J. Waldo Smith Hydraulic Fellowship may be offered every three years (instead of every two years as at present). This will permit increasing the grant to the student to $1,500 for the year's work in practical experimental hydraulics, plus as much more up to $500 as may be required for equipment for the project.

Committee Appointments

The Executive Committee approved the following appointments to committees as authorized by the Board of Direction. These are in addition to the appointments approved by the Board at its New York meeting (page 71).

Technical Division Contact Members: E. W. Carlton (Air Transport); J. P. Riley (City Planning); M. C. Prichard (Construction); R. H. Sherlock (Engineering Mechanics); R. R. Rowe (Highway); L. E. Rydell (Hydraulics); O. W. Hartwell (Irrigation and Drainage); C. L. Eckel (Power); S. B. Morris (Sanitary Engineering); R. F. Dawson (Soil Mechanics); T. C. Shedd (Structural); D. M. Corbett (Surveying and Mapping); and C. H. Brown (Waterways).

Committee on Engineering Education (Additions): Elmer K. Timby, Zone I; J. A. Higgs, Zone II; A. J. Ackerman, Zone III; and M. J. Shelton, Zone IV.

Task Committee on National Highway Program: B. D. Tallamy, chairman, A. N. Carter, H. E. Davis, DeWitt C. Greer, E. H. Karrer, R. M. Whitton, W. A. McWilliams, D. W. Winkelman, and Wm. Roy Glidden, Contact Member.

Task Committee on New Awards Policy: F. M. Dawson, chairman, Shortridge Hardesty, and Arthur E. Poole.

Task Committee on Scope of Professional Activity: Lloyd D. Knapp, chairman (Public Employee); Oscar S. Bray (Salaries Committee); Hamilton Gray (Educator); Mason G. Lockwood (Consulting Engineer); C. G. Paulsen (Civil Service); Roy T. Sessums (Ind. Employer); Charles W. Yoder (Employment Conditions Committee); and L. A. Elsener, Contact Member.

Task Committee on Convention Policy and Practice: D. V. Terrell, chairman, G. W. Holcomb, L. R. Howson, J. P. Riley, and Mason G. Lockwood.

Appointment to EJC Committees

The following nominations for appointment as ASCE representatives to committees of Engineers Joint Council were confirmed: *Executive,* Carlton S. Proctor, J. M. Garrelts (Alternate); *Constitution and Bylaws,* F. H. Paulson; *Finance,* G. W. Burpee; *Membership,* F. H. Paulson; *Honors for Engineers,* Malcolm Pirnie; *National Engineers,* Carlton S. Proctor; *International Relations,* E. H. Hamilton, E. A. Pratt, and W. H. Wisely; *Engineering Manpower Commission,* H. G. Dixon, G. A. Hathaway (Exec. Com.), and John P. Riley; *Atomic Energy Panel,* H. L. Bowman; *Employment Conditions,* Francis S. Friel; *Recognition of Specialties in Engineering,* Blucher A. Poole; *Practice of Engineering* (EJC-ECPD Joint), C. B. Molineaux; *Abstracting Services,* H. T. Larsen; *Who's Who in Engineering,* W. H. Wisely; *Air Pollution,* Seth G. Hess; *Water Policy Panel,* L. R. Howson; and *Subcommittee on Consulting Practice,* Shortridge Hardesty.

UET Elects New Officers

Walter J. Barrett, electrical coordination engineer of the New Jersey Bell Telephone Co., Newark, has been elected president of United Engineering Trustees, Inc., for the coming year. Mr. Barrett is treasurer and director of the American Institute of Electrical Engineers, which he represents on the Board of UET. He is also a director of EJC. Other officers elected are Willis F. Thompson and A. B. Kinzel, vice-presidents; Joseph L. Kopf, treasurer; George W. Burpee, M. ASCE, assistant treasurer; and John H. R. Arms, secretary and general manager.

Incorporated in 1904, UET acts in a fiduciary capacity for joint activities of the major engineering societies.

Board for Certifying Sanitary Engineers

Engineers interested in forming a board for certification of sanitary engineers are shown at a recent meeting to work out details. Left to right, seated, are T. R. Camp, Rolf Eliassen, Earnest Boyce, W. A. Hardenbergh, Robert Stiemke, Dwight Metzler, and Gilbert Dunstan. Standing, in same order, are John E. Kiker, Ray E. Lawrence, Frank Elder, Clarence Sterling, Alvin Meyer, Wendell LaDue, George O. Pierce, and R. S. Rankin.

As announced in the November and December issues, a board for certification of sanitary engineers has been set up. To certify the professional qualification of sanitary engineers in public health and other important assignments, papers of incorporation have been completed and signed for formation of an American Sanitary Engineering Inter-society Board. Earnest Boyce is chairman of the Board, which also includes W. A. Hardenbergh, vice-chairman; R. S. Rankin, treasurer; and Frank Elder, secretary. The office of the Board and its Certification Committee will be at ASCE Headquarters, 33 West 39th St., New York 18.

Ray Faust, chairman of the American Water Works Association, heads a Specialty Committee to work out certification procedures. Others on the Specialty Committee are Gilbert Dunstan, H. B. Gotaas, Harvey Ludwig, Ray E. Lawrence, T. R. Camp, J. E. Kiker, A. Brandt (ASME), and Frank Elder.

Water Storage and Use Data Released at Kansas City Conference

A new high in member service programs was reached by the Kansas City Section in sponsoring a Hydraulics Conference in November. Twelve speakers presented new information, ranging from results of rain stimulation to storm drainage, and City Manager L. P. Cookingham discussed the prestige engineers have earned in the development of Kansas City.

This first Hydraulics Conference for the Section was received with enthusiasm by some 350 engineers. Although planned primarily as a service to members in the area, the conference drew engineers from 16 states, the District of Columbia, and four foreign countries. For two days, November 21 and 22, this group was both informed and entertained with an outstanding program prepared by Robert W. Christy and his committee on arrangements. The host Section was represented in all proceedings by Glenn E. Hands, president.

Hydrologic Cycle Studied

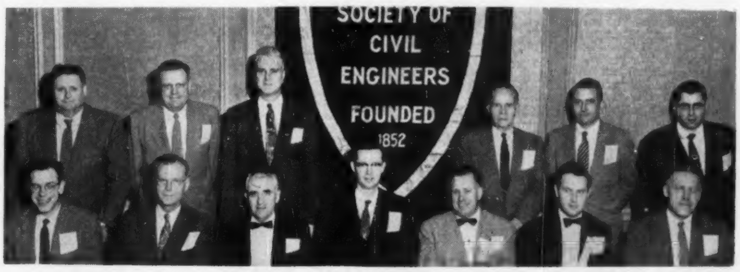
The opening session provided new data on rain stimulation and the hydrologic cycle in a paper presented by Dr. I. P. Krick, of the Water Resources Development Corp., and discussion on it. Specific projects were described. The related papers presented records of and prospects for water supply and utilization. Missouri resources were discussed by Dr. Garrett A. Muilenburg, assistant state geologist, and H. C. Bolon, of the U.S. Geological Survey. At a luncheon meeting Dwight Metzler, director of the State Division of Sanitation, related experience and plans of Kansas.

Models were much in the minds of those attending, with one whole session devoted to applications of model studies. Speakers at this session included: Dr. Lorenz Straub, head of civil engineering at the University of Minnesota; Thomas Murphy of the Waterways Experiment Station, who presented a paper prepared by Joseph B. Tiffany, assistant director of the Station; A. L. Jorissen, head of the hydraulics department at Cornell University; and Carl F. Izzard, chief of the Hydraulics Branch, U. S. Bureau of Public Roads. All warned that model studies are an aid to, not a substitute for good design.

Another session presented the results of hydraulic studies of particular concern to sanitary engineers. Storm-water drainage had been studied by E. E. Bloss, of Horner and Shifrin, who presented some of his conclusions on this program. L. Heckmann, of Layne Western Co., discussed the hydraulics of wells and galleries, which was followed by a description of pump applications by A. P. Weltner, of Allis-Chalmers. Water hammer and sedimentation tanks were dealt with in papers by H. H. Benjes, of Black and Veatch, and Don Bloodgood, professor of sanitary engineering at Purdue University.

Tours Conducted

Four tours were scheduled. Three were what might be expected—bus and car rides to places of interest, such as the Kansas City Water Treatment Plant, revetment under construction by the U. S. Corps of Engineers, and the hydraulics



Attendance at Kansas City Section's first Hydraulics Conference included (seated, left to right) A. P. Weltner, E. E. Bloss, Prof. Don Bloodgood, Dwight Metzler, Section President Glenn E. Hands, R. W. Christy, and Carl F. Izzard. Standing in same order, are H. C. Bolon, L. Heckmann, H. H. Benjes, ASCE Director C. L. Eckel, Don Reynolds, and Prof. C. D. Muir.

laboratory of the Fairbanks-Morse Co. The fourth was unusual, an armchair tour of various projects, with someone making the tour with a camera and bringing the results back to the hotel so the group could make the inspection in comfort.

Presiding conference officers were Dean M. A. Durland, of Kansas State College, Dean H. O. Craft, of the University of Missouri, and Prof. J. K. Roberts, of the Missouri School of Mines.

ASCE "Transactions" For 1955 Available

The 61 technical papers comprising the currently available 1955 TRANSACTIONS (Volume 120) will continue to uphold the high standards traditional with this publication. All 13 Technical Divisions have sponsored selected papers, insuring breadth of viewpoint and quality of subject matter, and the volume closes with President William R. Glidden's annual address. To complete the 1,652-page volume, there are discussions by distinguished engineers from all over the United States and abroad and 38 abstracts of memoirs of deceased members.

Copies are available to both members and non-members of the Society in the usual paper, cloth, and Morocco-grained bindings. Those who are not yearly subscribers to TRANSACTIONS and who have not previously ordered Volume 120 by other means may do so on the coupon provided in the advertising department in the back of this issue.

ESL Issues Bibliography On Machinery Foundations

Availability of a revised list of 175 annotated references to selected books and articles on machinery foundations—design, construction, and vibration elimination—is announced by the Engineering Societies Library. Identified as ESL Bibliography No. 11, the publication covers theory, design, and construction of machinery foundations; specific problems such as heavy machinery foundations on unstable soils; and vibration as related to foundations of hammers, oil engines, electrical machinery, turbines, steam engines, compressors, machine tools, pumps, etc. Bibliography No. 11 may be purchased from the Engineering Societies Library, 29 West 39th St., New York 18 (coupon on page 110). The price is $2.00.

New Assignment for ASCE Field Representative Ehlers

ASCE Field Representative Joseph H. Ehlers has been named assistant commissioner of the Urban Renewal Administration. He will serve as principal technical adviser to Commissioner James Follin, M. ASCE, and will direct the work of the six URA technical branches, including the Engineering and Planning, Municipal Finance, and Land Branches.

A former career civil servant, Mr. Ehlers has had extensive experience on public works programs of the federal government. He served as an assistant to the late Col. Henry M. Waite, Hon. M. ASCE, deputy administrator of the Public Works Administration, and in the Federal Works Agency as chief of the Consulting Engineering Division and assistant to the chief engineer.

Mr. Ehlers has been active in professional society and construction industry groups. Currently he is co-secretary of the Joint National Cooperative Committee of ASCE-AIA, and chairman of the Advisory Committee on Engineers of the U.S. Civil Service Commission. He is a graduate in structural engineering of the University of California and Cornell University, and also an attorney and member of the bar.

Joseph H. Ehlers (left), newly named assistant commissioner of the Urban Renewal Administration, is shown with Commissioner James Follin, to whom he will serve as principal technical adviser in his new capacity.

Coming Events

Cleveland—Annual dinner meeting at the University Club, January 20. Program will include election of new officers and a talk by President Enoch R. Needles.

Connecticut—Annual dinner meeting at the City Club in Hartford, January 26. President Needles will be the speaker.

Intermountain—Dinner meeting the third Friday of each month, except in June, July, and August. Exact time and place from Secretary R. E. Spears at El 9-8372.

Metropolitan—Meeting in the auditorium of the Engineering Societies Building, New York, N.Y., January 18, 7:00 p.m.

Northeastern—Annual meeting and election of officers at M.I.T. Faculty Club, January 30, 7:30 p.m. (preceded by social hour at 5:30 and dinner at 6:30). All Section past-presidents will be guests. Reservations through Secretary Ernest L. Spencer, Northeastern University, Boston, Mass.

Philadelphia—Regular meeting at the Engineers Club, January 10, 7:30 p.m.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

Syracuse—Regular meeting Tuesday evening, January 17. Exact time and place from Secretary Walter K. Neubauer, 320 Homewood Drive, Fayetteville, N.Y.

Scheduled ASCE Conventions

DALLAS CONVENTION
Dallas, Tex.
Hotel Baker
February 13–17, 1956

KNOXVILLE CONVENTION
Knoxville, Tenn.
University of Tennessee
June 4–8, 1956

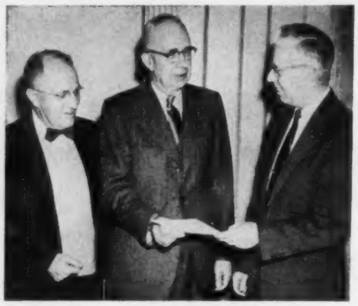
PITTSBURGH CONVENTION
Pittsburgh, Pa.
William Penn Hotel
October 15–19, 1956

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

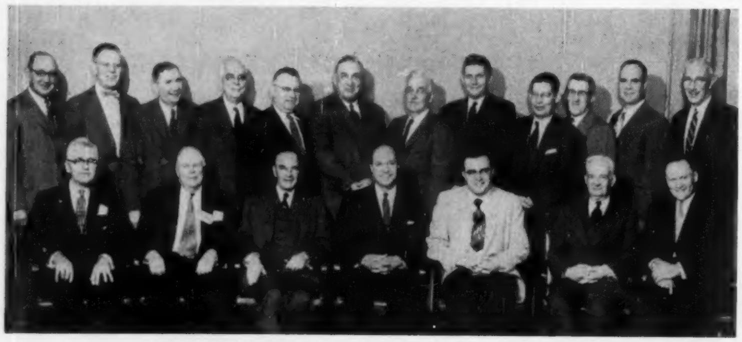
Transporting coal by pipeline was discussed at the **Cleveland Section's** November dinner meeting by Clarence Dauber, director of civil and mechanical engineering for the Cleveland Electric Illuminating Co. Mr. Dauber's company and the Pittsburgh Consolidated Coal Co. are installing a 108-mile line between Cadiz, Ohio, and Cleveland Electric's terminal plant at Eastlake, Ohio. There are three pumping stations on the line, which will have a handling capacity of 250 tons an hour. Mr. Dauber said that his company expects to obtain about 1,240,000 tons of coal a year by this method at a saving of about a dollar a ton. A pilot plant study, conducted by the Pittsburgh Consolidated Coal Co. at a cost of $2,000,000, proved the economic feasibility of the joint project.

The civil engineer's responsibility for community safety in the design of pressure containers for nuclear power plants was stressed in the leading talk at the **Columbia Section's** November meeting, which was held at Richland, Wash. Edgar F. Smith, of the Design Engineering Section, Hanford Atomic Products Operations, General Electric Co., was the speaker. New Section officers are Orrin H. Pilkey, president; Allen T. Gifford and Edwin C. Franzen, vice-presidents; and Edgar F. Smith, secretary-treasurer.



Prof. Herbert J. Gilkey (center), of Iowa State College, receives Life Membership Certificate at recent meeting of the Iowa Section at Des Moines. Shown with him are Lowell O. Stewart (left), secretary-treasurer of Section, and Section President Joseph W. Howe. Prof. Quincy Ayres was featured speaker, with a talk on patent problems of a college research foundation.

Members of the **Connecticut Section** and the Connecticut Society of Civil Engineers recently visited the new Sikorsky Aircraft Plant at Stratford. After the inspection tour and dinner the combined group heard William Kilpatrick, public relations manager of Sikorsky Aircraft, speak on the evolution of the helicopter and its uses—civilian and military.



Seventeen past-presidents of Cincinnati Section turn out to greet ASCE Executive Secretary William H. Wisely (fourth from left, seated) at recent dinner meeting of the Section. Seated, in usual order, are Bart J. Shine, Howard B. Luther, Henry D. Loring, Mr. Wisely, Section President George J. Kral, Hunter W. Hanly, and Warren W. Parks. Standing are Herbert H. Schroth, Lewis G. Hexem, Raymond W. Renn, Edgar D. Gilman, Harry A. Balke, Lester J. Backman, John S. Rafferty, Robert C. Vogt, Emil S. Birkenwald, Carl F. Renz, Sven E. Sjodahl, and Truman P. Young. Of the 22 living past-presidents, 19 are residents of Cincinnati. Fred F. McMinn and Harold W. Streeter were out of town and unable to attend.

The status of plans and studies for developing Duluth Harbor was reported at the November 21 meeting of the **Duluth Section** by Arthur M. Clure, chairman of the Duluth Port Authority. Expansion of present harbor facilities will be needed to handle the increased traffic expected to result from completion of the St. Lawrence Seaway. New Section officers are John H. Healy, president; Myron O. Thompson and Robert A. Fredstrom, vice-presidents; Albert J. Oman, secretary; and John T. Adams, treasurer.

The **Georgia Section** gave Life Membership Certificates to five new holders at its forty-third annual dinner held in Atlanta on December 3. Honored were Clarke Donaldson, Malcolm J. MacNabb, Schley Gordy, Lawrence W. Robert, Jr., and Joseph G. Wilburn. Section officers for 1956—installed during the meeting—are Byron A. Bledsoe, president; Burton J. Bell and Ralph S. Howard, Jr., vice-presidents; and Gordon G. Dalrymple, secretary-treasurer. ASCE President Enoch R. Needles was featured speaker, and the members of the Executive Committee (which met in Atlanta that weekend) were honored guests.

How engineers can make good use of available engineering statistics in designing safe highways was told members of the **Intermountain Section** attending the November meeting by A. LeRoy Taylor, engineering consultant to the Engineering Committee of the Utah Safety Council. Mr. Taylor presented an alarming picture of the highway safety (or the lack of it) situation. The committee he heads has been assembling statistics on accidents and other related and timely subjects.

At the **Hawaii Section's** annual Ladies' Night—held at the Queen's Surf in Honolulu on November 16—a color travel film, "Points East," was the entertainment, courtesy of United Air Lines.

New **Iowa Section** officers, elected at the annual meeting in Des Moines on November 22, are Joseph W. Howe, president; Fred F. Loy, vice-president; and Lowell O. Stewart, secretary-treasurer (reelected). Discussion of flexural testing of a prestressed concrete bridge beam at the Engineering Experiment Station at Iowa State College constituted the technical program. The discussion was headed by Dr. Cornie L. Hulsbos and David Van Horn.

New officers for Desert Area Branch of Los Angeles Section are (left to right) Richard W. Chaney, secretary-treasurer; Merle E. Fischer, president; and Harold E. Harney, vice-president.

Some still uncharted areas of sanitary engineering were explored in the leading talk at the **Kansas City Section's** November meeting by Kaarlo W. Nasi, sanitary engineer director and assistant chief of the U.S. Public Health Service's Water Supply and Pollution Control Program. Despite recent advances in the sanitary engineering field, Mr. Nasi said, it has been almost impossible to keep up with treatment demands in the field of water and air pollution. As a case in point, he noted that by 1980 scientists estimate it will take 2×10^{18} gal of water to dilute one type of anticipated atomic waste—or a supply equal to Missouri River flow past Kansas City for the next 150,000 years. Another important challenge to the sanitary engineering profession, according to Mr. Nasi, is to get more young men to enter it. In 1954 only 140 graduates from all colleges were sanitary engineers, in contrast to a normal average of 242.

The **Desert Area Branch** of the **Los Angeles Section,** centered in the Mojave Desert, reports that approximately 90 percent of its membership of 40 attend each meeting—something of a record in view of the fact that travel distance to meetings for many is 120 miles. New Branch officers, elected on December 2 and pictured elsewhere in this department, are Merle E. Fischer, president; Harold E. Harney, vice-president; and Richard W. Chaney, secretary-treasurer.

Interesting design features of the new Bangor (Me.) Auditorium were described at a recent **Maine Section** meeting by Eaton W. Tarbell, designing architect. Mr. Tarbell said that the wind bracing was the most difficult problem, and noted that the slope of the roof saves some 250,000 cu ft of heating space. The $1,400,000 community project will have seating capacity for 8,000. Officers of the **New Hampshire Branch** for 1956 are Charles O. Dawson, president; Nicholas J. Cricenti, vice-president; and Frederick T. Comstock, Jr., secretary-treasurer (re-elected).

Two experts in school construction covered the planning, design, and construction of the schools so badly needed, locally and nationally, in the featured talk at the **Metropolitan Section's** December meeting, which stressed economy in construction. They were William H. Correale, director of the Bureau of Construction of the New York City Board of Education, and Francis G. Cornell, of Engelhart, Engelhart and Leggett, New York City school planning consultants. At the November meeting the subject was flood control, and the speaker Brig. Gen. Robert J. Fleming, Jr., division engineer for the Corps of Engineers at Boston. There were turnouts of about 230 for these programs.

In a recent program devoted to prestressed concrete, **Miami Section** members were told of the plant facilities and prestressed concrete members available in the South Florida area. The experts were Prof. Murray Mantell, Werner F. Rosch, Merrill E. Crissey, and McKinney V. Taylor.

Raymond E. Sauer, of the Vicksburg District of the Corps of Engineers, told a recent meeting of the **Mid-South Section's Vicksburg Branch** of his experiences this summer in flood-stricken New England where he was in charge of emergency relief work for the Corps. At the same meeting the Branch elected new officers—Richard G. Ahlvin, president; Frank G. Meek, vice-president; and Dean R. Freitag, secretary-treasurer. The **Little Rock Branch** also announces its 1956 officers—William W. McMahon, president; William E. Isaacs, vice-president; and Eston E. Royse, secretary-treasurer. The alarming shortage of engineering manpower was discussed at a recent meeting of the **Jackson Branch** by Dewey McCain, head of the civil engineering department at Mississippi State College.

ASCE MEMBERSHIP AS OF DECEMBER 9, 1955

Members	9,057
Associate Members	11,640
Junior Members	18,058
Affiliates	70
Honorary Members	41
Total	38,866
(December 9, 1954	37,840)

The **Nashville Section** reports that "interest in ASCE has been tops this year" and attributes much of this good state of affairs to the efforts of local committees. At a recent meeting Ross Bryan, structural engineer on design of the Life and Casualty Office Building under construction in Nashville, described the massive steel members, complicated bracing, and unusual concrete footings-anchors required.

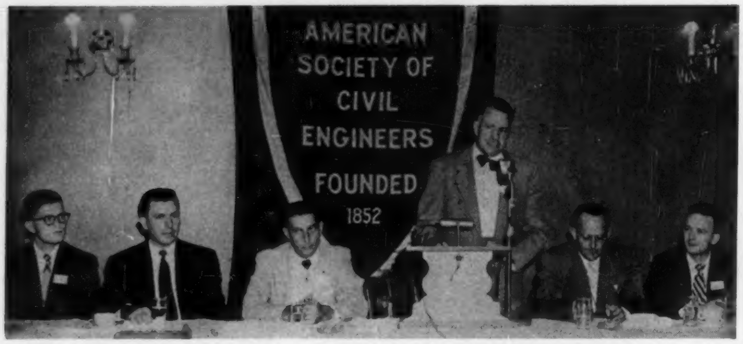
Bowen C. Huckleberry, head of the Bureau of Reclamation's Design and Specification Section at McCook, Nebr., will serve as junior vice-president of the **Nebraska Section,** filling out the unexpired term of the late Richard Green. Widely varying opinions on the fluoridation of domestic water supplies were rounded up at the November meeting by John Cramer, of Fulton and Cramer.

Plans for developing a more adequate highway system in the vicinity of the University of Minnesota were described at the **Northwestern Section's** November meeting by Hugo Erickson, city engineer of Minneapolis. The project involves replacing the Washington Avenue Bridge and eliminating a traffic bottleneck at the east end of the Franklin Avenue Bridge.

Progress made by the State of Oregon in its Water and Air Pollution Control Program was reported at the November meeting of the **Oregon Section** by Curtiss M. Everts, Jr., state sanitary engineer and director of the Division of Sanitation and Engineering of the State Board of Health.

Hubert N. Alyea, professor of chemistry at Princeton University and featured speaker at a joint meeting of the **Philadelphia Section** and the local section of the ASME on November 8, is being hailed by his large audience for one of the "most unique and exciting" talks ever heard by the Section. Dr. Alyea traced the growth of ideas leading to the making of the atomic bomb and outlined peacetime atomic developments. He noted that at the recent Geneva Conference "the weak nations of the world were informed they need not long fear exhaustion of fuel supply for power production. The magic of the breeder reactor, in which the neutron splits thorium and produces a uranium form suitable for fuel, can and will in the not distant future solve the fuel problem."

New **Pittsburgh Section** officers are E. D'Appolonia, president; William R. B. Froehlich, vice-president; and Merritt A.



Viewed at head table at recent meeting of Kansas City Section devoted to "Unions and Engineers" (December issue, page 72) are young men who presented the pros and cons of the controversial subject. In usual order, they are Robert E. Vansant, Albin H. Schweers, William E. Adams, Glenn E. Hands, Elmer M. Miller, and Elvin G. Ferguson.

New Mohawk-Hudson Section officers—elected at annual dinner meeting at Lathams, N.Y., on November 29—are (left to right) Herbert J. Johnson, secretary; Holbert Fear, treasurer; Gordon Ayer, president; Harold Britton, first vice-president; and Cliff Barton, second vice-president. Program featured presentation of Life Membership Certificates to William G. Craib and Leland P. Hover. Eligible but unable to attend were Albert J. Mantica and Nial Sherwood. In the featured talk New York State Historian, Dr. Albert B. Corey, discussed the history of the Hudson and Mohawk rivers and their influence on the area.

Neale, secretary-treasurer. At a recent joint meeting with the Civil Section of the Engineers Society of Western Pennsylvania, members heard M. W. Oettershagen, deputy administrator of the St. Lawrence Seaway Development Corp., discuss some engineering and economic aspects of the project.

The **Sacramento Section,** noted as one of the most active in the Society, complains in the "Engineerogram" that living within its boundaries are many civil engineers who do not belong to the Society, though they evince interest in the Society and Section by attending the weekly luncheon and other meetings. In order to make sure that every qualified engineer has an opportunity to join the Section, President Jennings declared December "New Member Month." George Sherman, of the State Highway Laboratory, heads a committee that will make it easy to join up.

M. J. Shelton, who has just completed a term as ASCE Director for District 11, was honored by the **San Diego Section** at its November meeting for doing an "exceptional job" as Director. San Diego Mayor Charles Dail presented him with the Section's gift of a barometer suitably inscribed. The featured speaker was Roscoe S. Porter, realtor and appraiser, who gave an illustrated lecture on the development of San Diego in the past seventy-five years.

Orchids to the **Spokane Section** on completion of the first year of publishing its "Bulletin," which does a fine job of rounding up the news. The Section has a flourishing Ladies' Auxiliary, which meets regularly and has just issued a comprehensive little year book, decorated with the ASCE badge and listing all members, officers, and committees.

Recent **Tri-City Section** programs have included a joint dinner meeting with the Illinois Society of Professional Engineers followed by a tour of the Davenport works of the Aluminum Company of America; a dinner meeting, addressed by Frank W. Edwards, head of the Chicago office of the Stanley Engineering Co., on the St. Lawrence Seaway Project; and a field trip to Keokuk, Iowa, to see the forty-year-old Union Electric Dam and Hydroelectric Power Plant and the Corps of Engineers Navigation Lock Reconstruction.

The **Virginia Section** has been authorized to form three Branches, with headquarters at Roanoke, Norfolk, and Richmond. This action came out of the October meeting of the Board of Direction in answer to a Section petition requesting the change.

New **West Virginia Section** officers—elected at the annual meeting in Charleston October 28 and 29—are David R. Agnew, president, and Wilson Ward and E. N. Blackwood, vice-presidents. Frank B. Wotiz will continue as secretary-treasurer. Guest Speaker at the gala dinner meeting was Webster N. Jones, vice-president of Carnegie Institute of Technology, who emphasized the need for more engineers and scientists. He noted that the United States has no system for attracting young, capable men to the profession of high school teaching and called it "a national calamity." Dr. Jones urged more attention in high school to mathematics, the physical sciences, and English to prepare students for scientific courses in college. He prophesied "inexhaustible opportunities for young men who choose engineering or science as their profession." One day was devoted to field trips to the United Fuel Gas Company's Office Building near Morris Harvey College, and the Charleston Sewage Treatment Plant at North Charleston.

There was a turnout of over 100 for the **Wisconsin Section's** November meeting, which featured a talk by Winfrey L. Hindermann, of the Asphalt Institute, on the subject of flexible pavements and a movie on the New Jersey Turnpike.

NEWS BRIEFS . . .

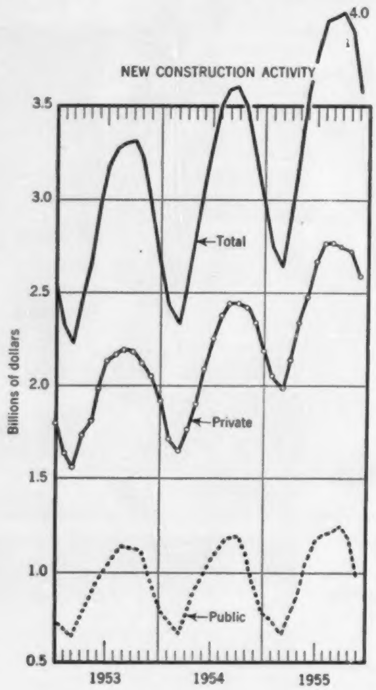
November Construction Sets Record Pace for the Month

While the value of new construction put in place in November declined seasonally, the $3.6 billion expended was 7 percent above the November 1954 total and set a new record for the month, according to preliminary joint estimates of the U.S. Departments of Commerce and Labor. On a seasonally adjusted basis, outlays for new construction were at an annual rate of $41.6 billion.

Private construction expenditures were down 5 percent this November, as residential building continued to reflect the recent decline in housing starts. Both private industrial building and office building, on the other hand, rose to new monthly records.

All major types of construction were represented in the 16 percent decline from October to November in public outlays. In most instances, however, the rate of decline was more moderate than the downturn usual for the time of year. Both highway construction and sewer and water work registered a greater volume of work put in place than in any previous November.

The joint agencies report that new construction expenditures for the first eleven months of 1955 came to $38.9 billion, topping last year's twelve-month total of $37.6 billion and virtually assuring a new annual record of $42 billion for 1955.



New construction put in place in November—at $3.6 billion—while reflecting the usual seasonal decline is 7 per cent above November 1954 and sets new record for the month.

Chicago's Tallest Building

New 41-story Mid-America Home Office of the Prudential Insurance Co., which was dedicated on December 8, tops other Chicago skyscrapers by some 44 ft. It is uniquely located on a 3¼-acre plot over 22 depressed tracks and the suburban station of the Illinois Central Railroad on the lakefront just north of Grant Park. Building and surrounding viaducts rest on 253 caissons sunk to bedrock at an average depth of approximately 100 ft. During the three and a half years of construction, there were no fatalities or serious accidents, though as many as 1,200 men a day were on the job. The building was erected by the George A. Fuller Co. from plans of Naess & Murphy, Chicago architects and engineers.

Contract Let for New England Thruway Work

A $10,797,151 low-bid contract for construction work on the New England Thruway in Connecticut has been awarded by the Connecticut State Highway Department to the Savin Construction Corp., a division of Merritt-Chapman & Scott's Construction Department. The work includes construction of a bridge over the Saugatuck River in Westport, overpasses in that town, and 32,636 ft of three-lane, dual-parkway paving in Darien and Norwalk.

Ground Broken for Cannonsville Project

In so far as snow-covered ground and freezing weather permitted, ground-breaking ceremonies for the $140,000,000 Cannonsville Dam and Reservoir Project, third and last phase of New York City's Delaware Water Supply Project, took place at Harvard, N.Y. (near Roscoe, 125 miles upstate), on December 19. A group of Board of Water Supply and other city officials, headed by Mayor Robert Wagner, were in charge of ceremonies initiating the project, which will tap the West Branch of the Delaware. When completed in 1961, it will add 310,000,000 gal to New York's daily supply and assure the city enough water for the rest of the century.

The first phase of the Cannonsville Project will consist of construction of a 44-mile tunnel to carry Delaware River water from Cannonsville Reservoir to Rondout Reservoir, a collection point. Construction of this part of the work will get under way at once under two combination low-bid contracts totaling $35,719,888. The contract is held by Johnson, Drake and Piper in a joint venture with Grafe-Callahan, Los Angeles; Winston Brothers, Minneapolis; Tecon Corp., Dallas; and Conduit and Foundation Co., Philadelphia.

The tunnel will have a finished diameter of 11 ft 4 in. (large enough to pass a subway car) and will include three 14 ft shafts and an intake at Cannonsville. Completion of this part of the work is scheduled for 1960.

Atoms-for-Industry Spotlighted at Nuclear Engineering and Science Congress

"The field of atomic energy is probably the most rapidly maturing technology that the world has ever seen," Casper W. Ooms, Chicago patent attorney and former chairman of the United States Commission of Patents, told delegates attending the Nuclear Engineering and Science Congress held in Cleveland's Public Auditorium during the week of December 12–16. The initial impetus came 13 years ago with the World War II development and production of atomic bombs by the United States. The control and utilization of this tremendous and abundant source of power for peaceful purposes was the subject of the Nuclear Congress, the first ever held in the United States and the most important since the International Conference in Geneva last August.

The Congress was coordinated by Engineers Joint Council—of which Thorndike Saville, M. ASCE, dean of engineering at New York University, is president—for 26 of the leading engineering and scientific groups in the United States whose joint membership totals more than 400,000. Dean John R. Dunning, of Columbia University's School of Engineering, was chairman of the general committee. As chairman of the Program Committee, Prof. Donald L. Katz, of the University of Michigan's school of chemical engineering, was particularly successful in obtaining for presentation, recently declassified papers believed valuable to the atomic industry. ASCE-sponsored papers related to the selection of safe sites for reactors; to the effect of radiation on the structural materials of a reactor; and to the difficult problem of safely disposing of radioactive wastes. These were offered by the ASCE Committee, headed by Prof. Harry L. Bowman, M. ASCE, of Drexel University.

ASCE representative on the Publication Committee was Walter E. Jessup, M. ASCE, editor of CIVIL ENGINEERING. Most papers were preprinted and as long as the supply lasts are available at 30 cents each from the Secretary of AIChE, 25 W. 45th St., New York 36, N.Y. Local arrangements for the Congress were made by the Cleveland Engineering Society in cooperation with the Cleveland Technical Societies Council, and under the chairmanship of Ralph R. West.

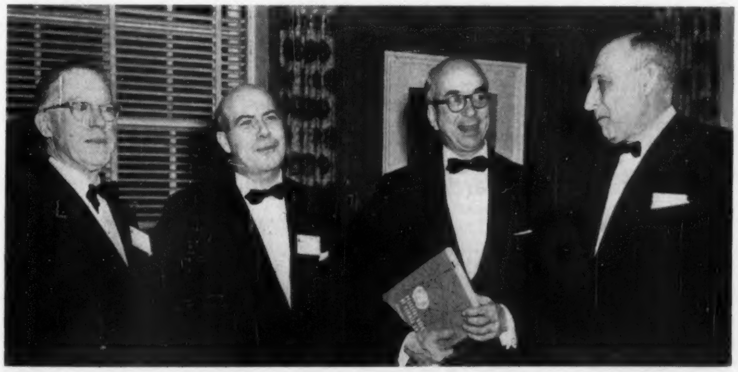
Of particular significance was the manner in which 26 organizations cooperated in harmony, and unified their efforts for the first time to achieve a common goal.

Atomic Exposition Attracts Public

Concurrently with the Congress and in an International Atomic Exposition also held in the same huge auditorium, 160 U.S. and foreign firms displayed and exhibited an amazing array of models of reactors, and the actual instruments, pieces of equipment and devices, all for the purpose of making available for peace-time uses the energy produced by splitting the atom. Open to the public, the exposition drew an attendance upward of 25,000. When Lewis L. Strauss, chairman of the United States Atomic Energy Commission, viewed the exhibit, he expressed the desire that a picture of each exhibit be bound together in a descriptive brochure and placed in every U.S. embassy and consulate.

Here were animated reactor models complete to figures of little men standing at control boards, with water or simulated liquid metal circulating to carry the heat from the core to exchangers for the production of steam, thence to steam turbines driving the electric generators. Here was a model of a design for the *Atomic Mariner*, a modern dry cargo ship powered by a pressurized water reactor patterned after that installed in the submarine *Nautilus*. Also displayed was a 7-ft-scale model of the homogeneous reactor (HRE-2) recently built for AEC. It is a 5,000-kw experimental plant, in which both fuel and moderator in solution form are pumped through the core to the heat exchangers. Models of several commercial plants, now under construction, were focal points of interest. New York University displayed its subcritical nuclear assembly put together for instruction and research purposes in a 5-ft-deep pickle barrel at a cost of but a few thousand dollars.

Prominent on the program of Nuclear Engineering Congress are, left to right, Thorndike Saville, president of Engineers Joint Council and dean of engineering at New York University; John R. Dunning, dean of Columbia University's School of Engineering and general chairman of the congress; Lewis Strauss, chairman of the U.S. Atomic Energy Commission and speaker at the All-Congress Dinner; and Joseph W. Barker, president of the ASME and of the Research Corp.



A 180,000-kw commercial atomic power plant, shown at the Atomic Exposition in this model, is to be built on the Illinois River 47 miles southwest of Chicago for the Commonwealth Edison Co. It will be the first privately financed atomic power plant in the United States. Completion before 1960 is scheduled.

Other displays exhibited new metallic alloys capable of withstanding heat, corrosion, and the damaging changes of physical properties which atomic radiation often causes in reactor materials; and new ways of casting special alloys in vacuum, of welding by shielded arc, and of accurate machining. The Exposition was sponsored by the American Institute of Chemical Engineers, of which Walter G. Whitman is president.

Atomic Power Technology Program

Principal peaceful use of atomic fission is the generation of electricity through the intermediate step of producing steam from the heat developed by controlled nuclear fission. It has been stated that by 1975 our country will be generating 80,000,000 kw of electricity from atomic energy. Dean Dunning predicted that in 10 years most large ships will be atomic powered. At present no commercial power reactor is in operation, although atomic power has lighted homes and turned industrial wheels.

Most of the 300 authors of the technical papers explained specific techniques in the overall process of producing power. The subjects of these papers ranged from the geology of the occurrence of the ore and the production of the metal uranium from it; through selection of safe sites for reactors; chemical processing and separation of the fissionable material; the technology of reactors, including the forms in which the fuel is fabricated and arranged in the core, heat transfer, control, shielding, and instrumentation; the effect of radiation on the reactor materials; to the disposal of the solid, liquid and gaseous wastes produced in the reactors and chemical separation plants, and the recovery of fission products. Other technical papers handled the detection of nuclear debris in water; the radiation pasturization of food; and the patent, insurance, legal, and medical aspects of the whole field. Steam turbines and electric generators in atomic power plants, being similiar to those in conventional steam power plants, were given but little attention during the Congress.

From Gettysburg President Eisenhower sent a message to the Congress, read to the Congress by Chairman Strauss of AEC, in which the President called attention to the need "to add more scientific and engineering brain power to our engineering force in order to make a more productive atomic future possible." Mr. Strauss announced that a two-month summer institute for 60 selected faculty members of American engineering colleges would open in June at the School of Nuclear Science and Engineering at Argonne National Laboratory, Chicago. National Science Foundation, AEC, and ASEE joined in developing plans for organizing and financing the institute.

Can the H-Bomb Be Harnessed?

"I am confident," predicted Mr. Strauss, "that the day will come, although probably not for years, when a way will be found to produce nuclear power by harnessing . . . the process of controlled fusion of the nucleii of lightweight elements." This elusive "big idea," he said, could revolutionize the atomic art. Unless we have scientists and engineers in quality and in number, he warned, we could lose the race to find the method of doing this before other countries discover it.

Permanent Barnhart Island Bridge Completed

Barnhart Island Bridge across the St. Lawrence River at Massena, N. Y., which was opened to traffic on December 15, is first completed permanent structure in the St. Lawrence Power Project. Rushed to completion during the past construction season at a cost of $5,000,000, the bridge provides access to the site of the Barnhart Island Powerhouse, which lies between Barnhart Island and the Canadian shore. It replaces a temporary floating bridge that must be removed before thick ice forms. Both bridges were built in very turbulent water and posed many construction problems. The new bridge carries two lanes of vehicular traffic and one railroad track, which will be removed when the power project is completed. Articles on both the temporary and permanent bridges appeared in the November and December issues (pages 53 and 38).

King and Slocum Named For 1956 Moles Honors

The 1956 Moles award for "outstanding achievement in construction" will go to Howard L. King, M. ASCE, of New York, and Harvey Slocum, of Alhambra, Calif. Formal presentation of the awards will be made at the annual Awards Dinner at the Waldorf-Astoria Hotel on February 2. Messrs. King and Slocum are the sixteenth pair of winners in a series that started in 1941 and numbers among its winners such notables as former President Herbert Hoover, Robert Moses and Admiral Ben Moreell.

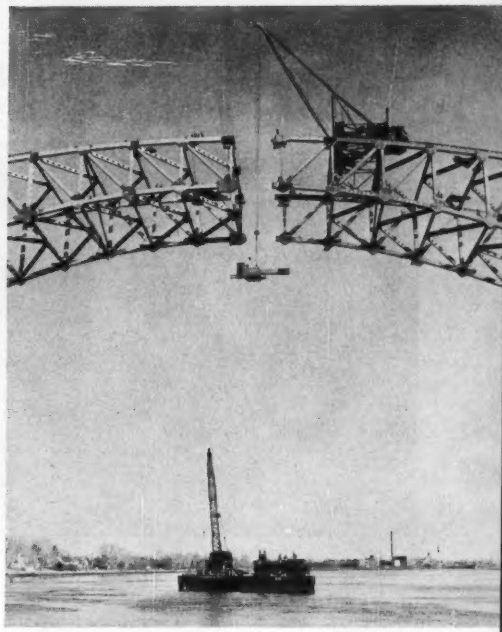
The award, which is considered the highest recognition that can be accorded service to the American construction industry, is made annually to one member and one non-member. Mr. King, this year's member winner, is vice-president and chief engineer of the Mason & Hanger Co. and an expert in driving compressed air subaqueous tunnels. Mr. Slocum, the non-member recipient, is considered one of the world's outstanding builders of concrete dams.

Huge Plaza Development For Downtown New York

A $75,000,000 plaza development, on the order of Rockefeller Center, is being planned for downtown Manhattan in the heart of the financial district. The center of the improvement—a cooperative project of the Chase Manhattan Bank and New York City—will be a 50- to 60-story Chase Manhattan Bank building, surrounded by a broad plaza.

The city's contribution to the coordinated development will be a housing project for 750 middle-income families. The cost of the housing development is estimated at from $7,500,000 to $10,000,000. To complete the improvement, the bank will build a 1,000-car public garage. A newly widened through street will provide access to the region.

Delaware River Bridge Connects Two Turnpikes



This new bridge going up across the Delaware between Edgely, Pa., and Florence, N.J., is one of the important projects in the nearly completed link between the Pennsylvania and New Jersey turnpikes. Here steelworkers of the American Bridge Division of U. S. Steel close the narrow gap between the two sections of the bridge with a 16-ton, 30-ft steel member. The steel was hoisted from a barge to its position near the top of the bridge, approximately 230 ft above the water. The bridge which will be ready for traffic early next summer, will have an overall length of 6,571 ft and will carry a six-lane highway. More than 20,000 tons of steel was required for its framework, erected on 28 land and two river piers.

Shortage of Scientists and Engineers Studied at Edison Foundation Institute

Proposals for more effective American competition with the giant strides that Russia is taking in producing scientists and engineers, were presented at the recent Sixth Thomas Alva Edison Foundation Institute, which was devoted to the growing shortage of scientists and engineers.

Lewis L. Strauss, chairman of the U. S. Atomic Energy Commission, emphasizing "freedom's need for the trained man," said, "we require from 45,000 to 50,000 new trained engineers every year. We are getting half that number. Last June's crop was around 23,000. Russia, at the same time, produced 53,000 new engineers and is expected to substantially increase that number next year and each year thereafter. She is graduating 120,000 new scientists and engineers of all types this year, which compares with our total of 70,000 graduates." Mr. Strauss went on to say that "it is a paradox that we should find ourselves at this point in history suddenly poorer in the very means by which our greatness was achieved. This is the cold war of the classrooms. In five years our lead in the training of scientists and engineers may be wiped out, and in ten years we could be hopelessly outstripped. Unless immediate steps are taken to correct it, a situation, already dangerous, within less than a decade could become disastrous."

Admiral Hyman G. Rickover, chief of the Naval Reactors Branch of the U. S. Atomic Energy Commission and the developer of the atomic submarine, proposed extending the school year, developing special schooling for gifted children, and said "we must see to it that every young man and women who is qualified obtains a college education. Today less than half of those capable of acquiring a college degree enter college. Sixty percent of the best students graduating from high school do not go to college. This is a tremendous loss of talent amounting to 250,000 students each year. We simply cannot afford a waste such as this."

Dr. Henry H. Armsby, chief for engineering education, U. S. Office of Education, opened the session at Thomas Edison's home in West Orange, N.J., by observing that "since we cannot hope to match the enemy in terms of numbers of men, we must surpass him in quality and utilization of our manpower."

Admiral Frederick R. Furth, chief of the U. S. Office of Naval Research, told the Institute that "members of the Russian Academy of Science are paid the equivalent of $36,000 per year. Russian mathematicians and scientists, *including teachers*, are among the best paid and most privileged of the community."

In contrast, in the United States, said Dr. Charles C. Cole, Jr., assistant dean of Columbia College, Columbia University, "the outstanding teacher is a breed facing extinction. Less than one out of every 100 boys in the top 30 percent of the high school graduates today wants to be a classroom teacher. Until we make teaching more remunerative, and give the teacher the prestige he deserves, you can hardly blame the other 99 percent."

Charles F. Kettering, Hon. M. ASCE and president of the Foundation, stressed the danger of specialization in education in developing the capacities of our future inventors, scientists and engineers. He said "there are two general kinds of education: one is learning a lot about one thing; the other is the almost disappearing kind where you learn something about a lot of things. An inventor has to have this latter kind of education. He can't be a physicist or a chemist or a biologist. He has to be whatever he has to be in order to solve the problem, because the problems are never specialized. The problems are what they are—not what we'd like them to be. Our education fails many times because we set up a pattern that is an average, and that is how we try to grade everybody. We try to make everybody alike."

Lehigh Portland Cement To Expand Iowa Plant

The Lehigh Portland Cement Co. announces plans to increase the capacity of its Mason City, Iowa, plant by 1,000,000 bbl annually. The expansion program, the second for the plant since the and of the war, will bring its total annual capacity to 3,000,000 bbl. By the end of 1957, when the present expansion project is completed, the company will have spent more than $122,000,000 for added capacity and rehabilitation in its postwar expansion program.

Contract Given for Cement Plant Project

Kaiser Engineers Division of Henry J. Kaiser Co., Oakland, Calif., has been awarded the design and construction contract for a $7,000,000 cement plant at Cape Girardeau, Mo., by the Marquette Cement Manufacturing Co. The project will add a second separate manufacturing unit, with a 1,250,000-bbl annual capacity to an existing Marquette plant, raising the company's total annual production at Cape Girardeau to 3,000,000 bbl, a 71 percent increase.

Construction will start in March and is scheduled for completion within eight months.

Mechanization Speeds New York Building Demolition

Mechanization in building industry reaches new heights in demolition of Seagram Building at 375 Park Ave., New York, which is being razed to make way for new $20,000,000 building. This is one of three tiny bulldozers working on the roof of the existing apartment house. As each floor is razed, they push demolished wall material and other debris into empty elevator shafts where it falls through chutes into waiting trucks. Safety sectional steel scaffolding is supplied by the Patent Scaffolding Co., Long Island City, N.Y. Another detail is the use of central, independent sources of gas, water, and electricity—not connected in any way with the building utilities—for use in demolition. Architects for the new building, which is scheduled for completion in 1957, are Mies van der Rohe and Philip Johnson with Kahn & Jacobs as associates. Structural engineers are Severud, Elstad & Kruger, and mechanical engineers Jaros, Baum & Bowles. George A. Fuller Co. is the builder. Demolition project was sublet to Lipsett, Inc.

Storm Surges Project May Prevent Loss of Life and Property

The disastrous Lake Michigan storm surge that came without warning one clear morning in June 1954, bringing an 8-ft wall of water and drowning a number of persons along the Chicago lakefront, could have been predicted in time to prevent this loss of life. A different kind of surge—the Atlantic flood of November 6 and 7, 1953, which caused tremendous damage to the Long Island, Staten Island, and New Jersey coasts—likewise could have been anticipated as could many other freak waves, that from time to time have taken a terrific toll of life and property.

This is the contention of three geologists at Columbia University's Lamont Geological Observatory at Palisades, N.Y., who will conduct a three-year project to test their theory that several hours warning of storm surges can be given. The important project, which is under the sponsorship of the American Institute of Mining and Metallurgical Engineers, is being instituted with an Engineering Foundation grant. In charge of the investigation are Dr. Maurice Ewing, director of the Observatory, Dr. Frank Press, and Dr. William L. Donn.

These scientists believe that when a line squall with its accompanying area of high pressure travels over water at a velocity equal to the normal velocity of a wave of water of the particular existing depth, a resonant effect is produced which can augment the normal wave to disastrous magnitude.

Fortunately the critical combination of atmospheric disturbance and natural wave period rarely occurs, but the Lake Michigan surge appears to have been one of these rare instances. While weather in the Chicago area was clear at the time the wave struck, two hours before it struck the area was visited by a severe squall with winds up to 66 mph. The squall was accompanied by a pressure-jump, or band of increased air pressure. After passing over the city, the squall and pressure-jump traveled 40 miles across Lake Michigan, arriving at Michigan City, Ind. (on the eastern shore directly across from Chicago) simultaneously with a wave from the northwest. Eighty minutes later the reflected 8-ft wave washed back on the Chicago lakefront.

The idea is not completely new. It has been suggested by British scientists as a possible explanation for abnormally high Thames River tides and for a disastrous surge occurring off the Sussex coast in July 1929. However, the project getting under way at the Lamont Observatory with Engineering Foundation support is the first attempt to formulate a scientific explanation of the Lake Michigan freak wave and to prove the theory of air-to-water coupling.

Since only for equal velocities can a large wave be generated, the project will have to show that appropriate velocities existed at the time of the surge. From U. S. Weather Bureau records of past storms and surges, it is studying surges to see whether appropriate storms existed, and appropriate storms to see whether they generated surges. With these studies as a basis, trial forecasts of lake surges will be made.

The program of course involves continuous monitoring of the kind of atmospheric disturbances Drs. Ewing, Press, and Donn think is responsible for the Lake Michigan-type surge. This check on storms will be handled by a new type of instrument sensitive enough to record disturbances that might generate small surges as well as those of more disastrous size. This will mean more case histories to work with. The instrument—made especially for the project and called the Wallace Microbarograph—is being installed at a lake station.

Water-level records must be carefully studied, too, of course. And to be sure of the complete accuracy of the recorder used, the geologists are building their own in the heavy-metal shop the Observatory boasts—a shop equipped for making everything from the most delicate watch spring to a heavy pile driver. The water-level recorder will also be installed at a lake station and operated by the U. S. Lake Survey, which will mail daily records to the Observatory.

When the studies of Great Lakes atmospheric disturbances and water levels are well established, the storm surges investigations will be extended to the coastal oceanic type of flood, with the Atlantic flood of November 1953 the special case study. After these two studies are completed, the Lamont Observatory geologists expect to investigate surges of both types in the Gulf of Mexico, the Caribbean, and Lake Maracaibo, where they will have special significance in offshore oil-drilling operations.

If the project confirms their theory, it will probably mean that several hours' advance warning of freak waves can be given on the basis of the position and velocity of a line squall. It may also mean that such waves can be forecast for an area from a study of the occurrence of similar disasters in the past.

Aluminum Output for 1955 at All-Time High

For the fourth consecutive year the United States aluminum industry has established new all-time records. Industry estimates indicate that, for the first time, primary aluminum production during 1955 will exceed three billion pounds—about 7 percent over the 1954 total.

Shipments of semifabricated aluminum products by members of the Aluminum Association, which has prepared these estimates on 1955 production, show large increases in 1955 over the preceding year.

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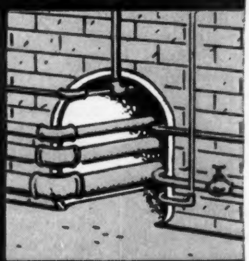

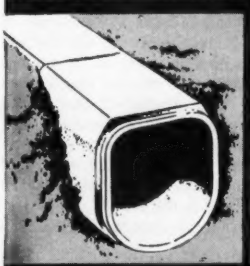

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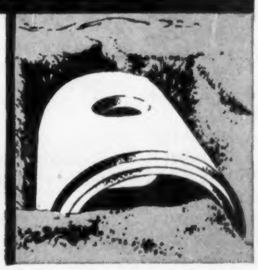

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Production of aluminum ingot from scrap also showed a substantial increase in 1955. Statistics compiled by the U.S. Bureau of Mines indicate a rise of 26 percent in the consumption of aluminum-base scrap during the first six months of the year. Figures for the second half are expected to show a comparable advance over 1954.

Despite record production, the metal was in tight supply during the year as a result of the continued rise in demand for aluminum products. The situation was partly relieved by the government's action in diverting to industry substantial amounts of metal from stockpiling calls. The Office of Defense Mobilization has announced that there will be no calls for the stockpile in the first and second quarters of 1956. Including the amounts to be deferred during the first half of next year, the government will then have made available for civilian use a total of 900,000,000 lb of aluminum since the first quarter of 1955.

One new primary producer began operation during 1955, bringing the number of producers in this country to four. Several other companies are planning to enter the primary aluminum industry. The new plants planned by these companies, together with the expansion projects of existing producers, would add more than a billion pounds to the nation's annual primary aluminum capacity. Plans for increased aluminum production are being matched by increased mining of bauxite ore in all areas and new ore-refining capacity.

Two notable conferences were held by user groups during the year. The first of these was a three-day conference on the electrical utilization of aluminum held by the AIEE, and the second a conference on curtain walls sponsored by the Building Research Institute. Notable applications in the building field include increasing use of colored porcelain enameled aluminum sheet on building exteriors. Both sheet and extruded products also are being produced in a wider variety of anodically applied colored finishes.

N*G*Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

The 16th annual meeting of the Engineers Club of Esseyeville left little time to Professor Neare, so he didn't fool around. "Joe," he asked, "did you do it, or shall I call on Cal?"

"Both," temporized Joe Kerr.

"Meaning he did it wrong," guessed Cal Klater.

"Perhaps, but I got the right answer quick. Let's see your hard right way first."

"Humor him, Cal," ordered the Professor.

"Well my way is easy, too. There were x equally popular lectures and k men chose each possible pair, making $^1/_2kx(x-1)$ registrants. If $^1/_2k(m-1)(m-2)$ left before the mth lecture and $^1/_2k(x-m)(x-m-1)$ came afterwards, the attendance at the mth was

$$k(mx + m - m^2 - 1) = 49. \quad .(1)$$

and analogously at the nth,

$$k(nx + n - n^2 - 1) = 169. \quad .(2)$$

With 49 and 169 relatively prime, $k = 1$, leaving the relation

$$x + 1 = m + \frac{50}{m} = n + \frac{170}{n}. \quad .(3)$$

I could have solved the diophantine in m and n, but it was easier to try the few factors of 50 and 170 to find a pair that gave the same value of x, which turned out to be 26. How could Joe do it any easier?"

"In my head," scoffed Joe. "I could see $k = 1$, that $x - 1$ came for the first lecture, $x - 2$ for the second, and so on. But one left before the third and 2 more before the fourth, so the series of increments became $x - 1, x - 2, x - 4, x - 6 \ldots$. First I tried $x - 1 = 49$ and added $49 + 48 + 46 + 44$ until I passed 169. Next I tried $x - 1 + x - 2 = 49$ and found the series $25 + 24 + 22 + 20 + \ldots + 8 = 169$. All in my head I did it, standing up in a bus, no pencil—no hands. Easy."

"Next time I'll make the numbers bigger," laughed the Professor. "I wasted a lot of time on the set-up, thinking you'd try to make something of 49 and 169 being squares, but maybe I can point out a moral. On a long program, don't let yourself be scheduled to lead off or wind up, unless the doors are locked.

"In Phoenix last November I was amazed at the competitive development of back-yard swimming pools. Everybody who is anybody has at least one, the well-to-do have two, and the affluent three. One affluent granddame, aspiring to be a ne-plus-ultra, ordered a fourth, as large as possible. Already squeezed in her walled patio were the Purple Pool, the Pink Pool and the Pearl Pool, with diameters of 330, 385 and 440 ft respectively. How big could the new Pinto Pool be if all were circular like the patio?"

[*Joe was so smart that he is listed with the Cal Klaters, who were: Ed C. Holt Jr., Thatchrite (Guy C. Thatcher), Marvin (Sauer Doe) Larson, and R. E. Philleo.*]

NUCLEAR NOTES

XVII—Attenuation of Photons in Matter

The December installment of this article on shielding against radiation discussed the tolerance of human beings to exposure to radiation. This part, also by R. H. Ritchie, of the Health Physics Division of the Oak Ridge National Laboratory, Oak Ridge, Tenn., covers the basic attenuation laws of photons in matter. This column appears monthly under supervision of the Sanitary Engineering Division's Committee on Sanitary Engineering Aspects of Nuclear Energy, of which Conrad P. Straub is chairman. The other members of the committee are Earnest F. Gloyna, A. E. Gorman, Prof. Warren J. Kaufman, Alexander Rihm, Jr., and James G. Terrill, Jr.

Geometrical Attenuation: The inverse square law is very important in the attenuation of radiation. It has counterparts in many other physical laws, such as gravitation, electrostatics, etc. In the case of radiation, it merely expresses the conservation of particles or photons. If a point source of gamma rays emits S photons per second, then in the absence of absorption, just as many photons per second must cross a sphere of radius r_1 with center at the source as cross a similar sphere of radius r_2. Then if ϕ_1 is the photon flux at the sphere r_1 and ϕ_2 the flux at r_2, expressing conservation of photons mathematically

$$S = \phi_1 \times 4\pi r_1^2 = \phi_2 \times 4\pi r_2^2, \text{ or}$$

$$\text{photons emitted per sec} = (\text{flux} \times \text{area})_1 = (\text{flux} \times \text{area})_2$$

or

$$\frac{\phi_1}{\phi_2} = \frac{r_2^2}{r_1^2}$$

Similarly, the flux ϕ at a distance r from the source is given by

$$\phi = \frac{S}{4\pi r^2}$$

Material Attenuation: Suppose a broad collimated beam of low energy γ-rays is incident normally upon a slab of high atomic number material and that the predominant interaction is the photoelectric process in which the photons are completely absorbed. Then a certain fraction μ of the flux $\phi(x)$ at distance x in the slab will be removed per unit length via the photoelectric process. Then we may write for the number $d\phi$ removed in the thickness dx

$$d\phi = -\mu dx \phi(x)$$

$$\frac{d\phi}{dx} = -\mu\phi(x)$$

This equation has a formal similarity to

the equation of radioactive decay. The solution has the form

$$\phi(x) = \phi_0 e^{-\mu x}$$

where ϕ_0 is the flux at the entrant surface of the slab.

Fig. 2 gives values of the mass absorption coefficient $\mu_m(\text{cm}^2/\text{gm})$ for various substances as a function of the photon energy E[1]. To obtain the linear absorption coefficient μ (cm^{-1}) from these curves, one has only to use the relation

$$\mu = \mu_m \rho$$

where ρ is the density (gm/cm^3) of the material. If more than one element is present in the attenuating material, the effective absorption coefficient is given by

$$\mu = (\mu_{m_1} f_1 + \mu_{m_2} f_2 + \ldots)\rho$$

where $f_1, f_2 \ldots$, etc., are the fractional mass abundances of elements 1, 2, ..., etc., in the material. In most cases the simple exponential absorption law given above is not obeyed exactly, due to Compton scattering in which the photon is not absorbed but merely degraded in energy. The degraded photon may proceed to penetrate further before finally being absorbed. The presence of these degraded photons leads to the "buildup" of dose in addition to that predicted by the exponential law. The calculation of the dose buildup factors $B(\mu x, E)$ which are functions of both x, the photon energy and the attenuating material is a difficult job requiring high-speed electronic computers and very sophisticated mathematics. In Figs. 3 and 4 are given approximate dose buildup factors $B(\mu x, E)$ for several materials.[2] These values of $B(\mu x, E)$ are somewhat larger than the true values since they were calculated for a plane monodirectional source in an infinite medium. Thus use of these values provides a factor of safety in designing gamma shields. It is easily seen that buildup is much more serious in the lighter elements than in the heavier ones because of the relative importance of Compton scattering. Also, elements of high atomic number have larger absorption coefficient per unit mass than those of low atomic number. For these reasons elements of high atomic number are preferable for shielding against gamma rays. Lead is commonly used for this purpose but for structural and economic reasons concrete and steel are often employed.

"Complete" Equation for γ Attenuation

Combining the above attenuation laws, we may write for the dose rate at r cm from a source of strength S (photons/sec) and energy E which is shielded by a slab of matter having thickness x, absorption coefficient μ and dose buildup factor $B(\mu x, E)$;

dose rate in roentgen/hr =

$$D(E)\,\frac{S}{4\pi r^2}\,e^{-\mu x}\,B(\mu x, E).$$

where D(E) is given in Fig. 1.

When composite slabs of different materials are used a conservative procedure is to assume that the material attenuation is a product of the attenuation in the individual materials. Thus for photons penetrating a shield composed of two different materials having thicknesses x_1 and x_2, dose buildup factors B_1 and B_2, and absorption coefficients μ_1 and μ_2, respectively.

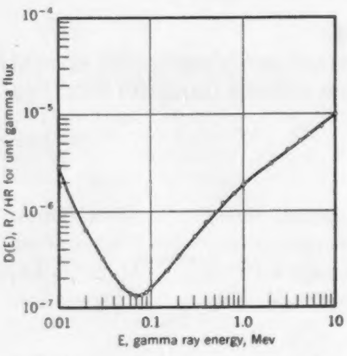


Fig. 1. Gamma Dose vs. Energy for Unit Incident Flux.

$$\text{Dose rate} = D(E)\,\frac{S}{4\pi r^2}\times \{e^{-\mu_1 x_1} B_1(\mu_1 x_1, E)\}\{e^{-\mu_2 x_2} B_2(\mu_2 x_2, E)\}$$

and similarly for three or more materials.

Some problems illustrating the principles discussed above will be solved in next month's installment.

[1] W. S. Snyder and J. L. Powell, "Absorption of γ-Rays," ORNL-421. For a more recent compilation, see G. R. White, "X-Ray Attenuation Coefficients from 10 kev to 100 Mev," NBS-1003. Obtainable from Supt. of Documents, Government Printing Office, Washington 25, D.C.

[2] H. Goldstein and J. E. Wilkins, "Calculation of the Penetration of Gamma Rays," NYO-3075. Obtainable from the Office of Technical Services, Dept. of Commerce, Washington 25, D.C.

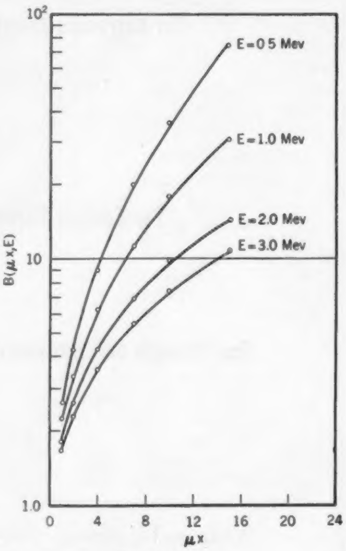


Fig. 3. Dose Buildup Factor vs. μx for water.

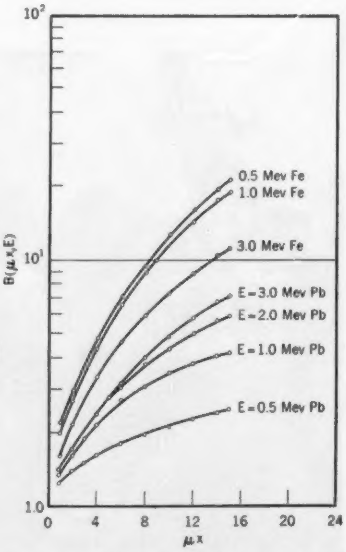


Fig. 4. Dose Buildup Factor vs. μx for Pb and Fe.

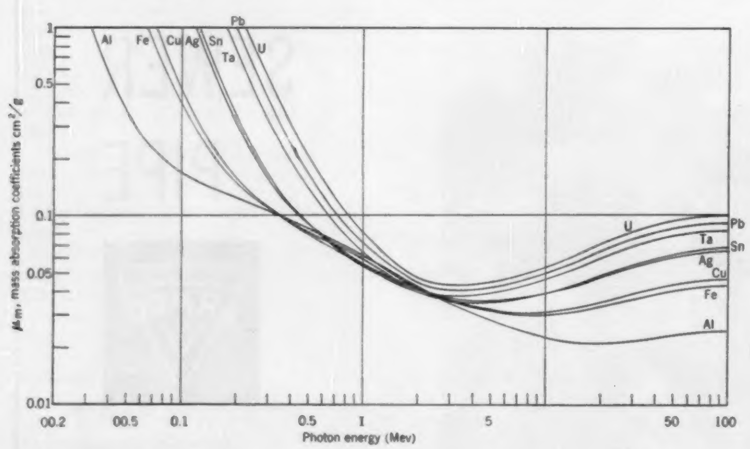


Fig. 2. Mass Absorption Coefficients vs. Photon Energy.

DECEASED

Fred Eugene Ayer (A.M. '10), age 78, dean emeritus and founder of the college of engineering at the University of Akron, died October 9. After graduating from Lafayette College in 1900, Mr. Ayer served as a draftsman for such companies as Pennsylvania Steel, American Bridge, New Jersey Bridge, and Great Falls Iron Works. For the next eight years, he was in the civil engineering department of the University of Cincinnati. Mr. Ayer was with the University of Akron for 32 years, retiring in 1947.

Burwell Bantz (M. '44), age 71, city engineer of Chehalis, Wash., and former director of the Washington State Highway Department, died in Chehalis on November 22. A 1909 graduate of the University of Washington, Mr. Bantz was an engineer for the City of Seattle, the Northern Pacific Railroad, and the Washington State Highway Department in his early career. His later assignments included Island County engineer, Lewis County engineer, city engineer of Tacoma, and right-of-way engineer for the State Highway Department. Mr. Bantz was state highway director from 1941 to 1945.

Burwell Bantz

Theodore Belzner (Aff.'10), age 76, retired bridge inspector in charge of Brooklyn Bridge and veteran New York City employee, died at his home in Brooklyn, N.Y., on November 18. Mr. Belzner attended Cooper Union and City College of New York before joining the Corps of Engineers for three years. In 1901 he began a 51-year association with the City of New York. He worked as inspector on many of the city's bridges, and was on Brooklyn Bridge from 1924 until his retirement in 1952.

Frederick Louis Bixby (M. '19), age 74, retired head of the University of Nevada's civil engineering department, died November 13. A 1905 graduate of the University of California, Mr. Bixby was for eighteen years senior irrigation engineer for the Department of Agriculture. He then became a professor of civil engineering at the University of Nevada at Reno, heading the department from 1942 until his retirement in 1950.

Blair Irving Burnson (A.M. '46), age 43, executive assistant to the general manager of the East Bay Municipal Utilities District, Oakland, Calif., and vice-president-elect of the San Francisco Section, died on October 26 after a brief illness. Mr. Burnson joined the District as a supervising engineer, following his graduation from the University of California in 1935. In May 1954 he assumed the post of executive assistant to the general manager. He had been active in the Section and chairman of its Professional Employees Committee.

Blair Burnson

William Joseph Carroll (A.M. '32), age 57, partner in Polosolli & Angelucci, Philadelphia, Pa., died on October 1. Soon after his graduation from Drexel Institute in 1923, Mr. Carroll became division engineer with Bituminous Service Co., Inc., West Chester, Pa., and remained there for thirteen years. He was then briefly associated with the Asphalt Sales & Contracting Co., Inc., of Paoli, Pa., before becoming a partner in the firm of Polsolli & Angelucci, of Philadelphia.

John N. Chester, Former Vice-President, Is Dead

John Needles Chester, (M. '01), age 91, former Vice-President of ASCE and retired Pittsburgh consultant, died on November 1 at Champaign, Ill., near where he was born in 1864. He was an 1891 gradute of the University of Illinois. Early in his career Mr. Chester was chief engineer of what is now the American Water Works and Electric Co. for seven years, and general manager of the Epping-Carpenter Co., Pittsburgh pump manufacturers. In 1910 he formed a partnership with Thomas Fleming for the practice of hydraulic and sanitary engineering. The company, now known as the Chester Engineers, served many cities. Mr. Chester was a pioneer in the development of rapid sand filtration, and responsible for several inventions in the field. A member of ASCE since 1892, he served as Director from 1922 to 1924 and as Vice-President in 1931 and 1932. He had also been president of the Engineers Society of Western Pennsylvania.

William Grant (M. '10), age 83, of Fort Worth, Tex., died October 14. After graduation from the University of Nebraska in 1897, Mr. Grant spent twelve years with the Chicago, Burlington & Quincy Lines East and West. He then served as city engineer of Lincoln, Nebr. Beginning in 1909, he engaged in private practice for a number of years. More recently he was an engineer with Freese and Nichols, Fort Worth engineers.

Aloysius Frank Harter (A.M. '17), age 72, retired civil engineer of Phoenix, Ariz., was drowned near there on October 19 when his fishing boat capsized. Mr. Harter had been assistant city engineer of Phoenix; on the staff of the Arizona Highway Dept.; county engineer of Maricopa County, Arizona,; city engineer of Globe, Ariz.; and chief field engineer for Headman, Ferguson & Carollo, Phoenix. During World War I he was a captain in the Corps of Engineers.

Ely Champion Hutchinson (M. '18), age 73, retired industrial executive and engineer of Washington, D.C., died there on November 12. A native of San Francisco, Mr. Hutchinson became connected with the Pelton Water Wheel Co., of San Francisco, early in his career, rising to the presidency and general managership. Later he was editor of *Power* magazine in New York; president of the Edgemoor Iron Co., of Wilmington, Del.; and manager of Alcoa Products, Inc., New York. During World War II he served on the War Production Board and in other government and public service capacities. At one time he was vice-president of the ASME.

Daniel Joseph Liccione (A.M. '39), age 49, since 1940 naval architect at the New York Naval Shipyard, Brooklyn, and a member of the Metropolitan Section, died on October 17. Mr. Liccione had been with the New York Edison Co.; the New York Board of Transportation; the Electric Bond and Share Co.; the New York Department of Public Markets; and the Corps of Engineers. He was a graduate of the Polytechnic Institute of Brooklyn, class of 1933.

Herbert Dale Lott (A.M. '43), age 48, an authority on loads and resources of the Northwest Power Pool, died suddenly at his home in Portland, Ore., on October 20. Since 1943 he had been associated with the Bonneville Power Administration as system operations and resources engineer, preparing weekly reports on the operations of the Administration for all the utilities of the region. Earlier Mr. Lott was with the Widmer Engineering Co. and the Burns & McDonnell Engineering Co. He was a graduate of Kansas State College, class of 1930.

(*Continued on page 96*)

Deceased

(Continued from page 94)

Ray Messinger Murray (M. '12), age 79, consulting engineer of Seattle, Wash., died there on October 20. An 1897 graduate of Ohio Northern University, Mr. Murray was instructor and then dean of the College of Engineering at his alma mater until 1919. He then had a private practice in Billings, Mont., for ten years and in Spokane, Wash., for two years. From 1929 until 1952 he worked with the Washington State Highway Department and the Seattle engineering department, and for the past three years had been engaged in planning a bridge and highway improvement program for the city of Ketchikan, Alaska.

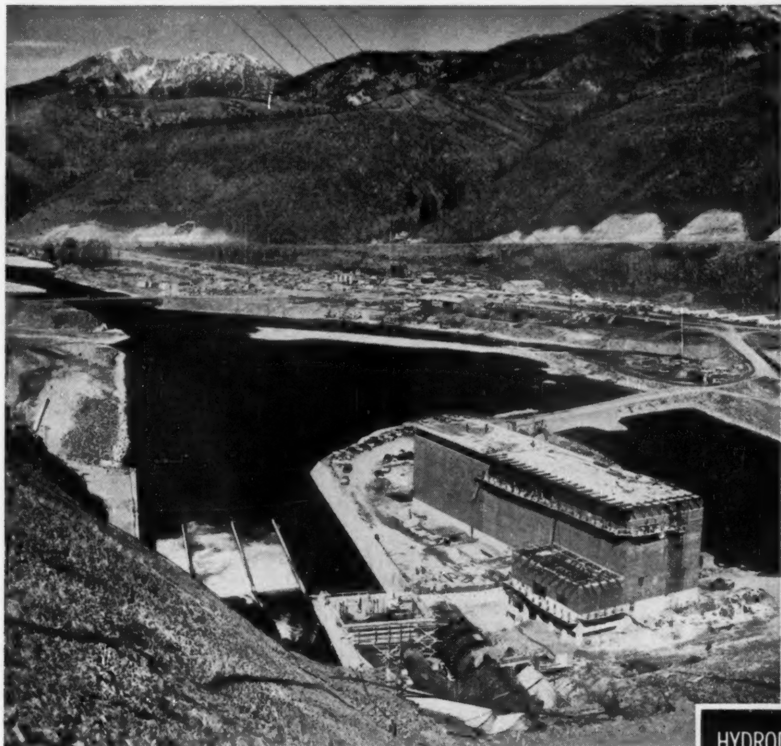
Foster Alfred Pakcard (A.M. '54), age 23, of Scottville, Mich., died September 11. Mr. Pakcard graduated from the University of Notre Dame in 1954 with a degree in civil engineering. At the time of his death, he was a Naval officer candidate.

Robert John Ratner (J.M. '48), age 28, highway engineer for Rader and Associates, of Miami, Fla., died there on November 21. Mr. Ratner had been assistant highway engineer for the California Division of Highways, Los Angeles; designer for the Fluor Corp., Los Angeles; and civil engineer for Benedict, Beckler and Kocher, Los Angeles. He was a 1948 graduate of Cornell University.

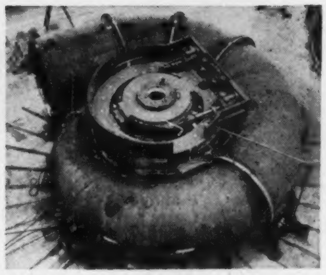
Frank Rullan (A.M. '29), age 57, of San Juan, Puerto Rico, died April 28, 1955. Born in Puerto Rico, Mr. Rullan graduated from the University of Puerto Rico in 1919. At the time of his death, he was president of Frank Rullan Associates, Inc., San Juan, Puerto Rico. For a number of years Mr. Rullan was with Gibbs and Hill, of New York, on construction of the outdoor substation for electrification of the Pennsylvania Railroad.

William George Seyfang (M. '40), age 70, public works commissioner of Buffalo, N.Y., died there on November 1. Following his graduation from Cornell University in 1909, Mr. Seyfang was with the Westinghouse, Church, Kerr Co., in New York, and the Eastern Concrete Steel Co., of Buffalo. In 1916, he participated in forming the Tifft Construction Co., and became its vice-president. After seventeen years the company was dissolved and Mr. Seyfang became chief engineer of the Fleischmann Malting Co., leaving in 1937 to assume duties as co-ordinator of the

(Continued on page 106)

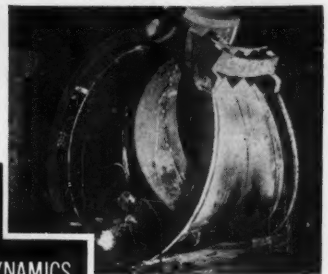


View downstream from the dam toward the powerhouse shows the irrigation bypass (left), penstock (center) and tail-race canal (right). *(U.S.B.R. photo)*



Final check assembly of Unit #2 – a complete scroll case, pit liner, distributor gates and operating mechanism – is made in SMS shops prior to shipment to the site.

Welding a flange to a section of Unit #3's spiral steel case. SMS shops are completely equipped to fabricate weldments of the largest types.



Canadian power development

(This article begins on page 38)

(*Continued from page 42*)

amortisseur windings, and have direct-connected exciters and static voltage regulators. Six are of the conventional type with thrust bearings above the generator, and six of umbrella type with thrust bearings below the rotor. The generators are below the operating floor of the powerhouse, with only the exciters and governor cabinets extending above this level.

Heavy equipment was transported to the powerhouse over a road built for the purpose, leading down into the gorge from a point near the Niagara Glen. A service elevator from an entrance building at ground level and a tunnel lead directly to the north end of the powerhouse.

The control room is at the north end of the powerhouse, at the level at which the access tunnel enters. It is designed to house the control equipment for plant No. 1 also, since the two plants will eventually be operated as a unit.

Pumped storage development under construction

The pumped-storage development is designed as an adjunct of the main development, to make use of any surplus energy during night hours to pump water into a reservoir, whence it can be drawn to generate primary energy in daytime periods of high demand. The development comprises a short canal, a pumping and generating station, and a reservoir—all now under construction.

Just above the crossover of the No. 1 and No. 2 canals, a short canal leads off to the pumping station, as shown in an accompanying photo. Here six feathering-blade, diagonal-flow pumps are being installed driven by 55,000-hp, synchronous motors. The pumps have a rated capacity varying with the pumping head from 4,000 to 5,500 cfs and will discharge directly into a reservoir having an area of 735 acres and a capacity of 16,000 acre-ft, with a water level varying between Els. 600 and 625.

This reservoir, confined by rock and earth-fill dikes, lies roughly parallel with the canal, and is about 2 miles long and half a mile wide. The six pumps are capable of filling the reservoir in about eight hours.

When the flow is reversed, the pumps become turbines and the motors become generators, each with a capacity of 46,000 hp under the full reservoir head of 85 ft. The flow from the reservoir will augment that drawn from the river at the same time, and will pass on down to the forebays to be used in the main generating units of the development.

The pumped-storage powerhouse has no superstructure. Split hatch covers on rails cover the motors at deck level, and the whole is serviced by a housed-in gantry crane. An erection bay is provided at one end, also below deck level, with split hatch covers.

Remedial works near completion

It will be appreciated that the diversion of such large amounts of water from the river to supply present and projected power developments, thereby reducing the flow over the Falls to the permissible minima named in the Treaty of 1950, cannot fail to have a considerable effect on water levels in the river itself and even, to a lesser degree, in Lake Erie. The distribution of flow would also be altered and the scenic spectacle very adversely affected. This was visualized in drafting the Treaty, and Article II provides for the construction of suitable remedial works.

Model studies were made cooperatively by the U.S. Corps of Engineers at Vicksburg, Miss., and by the Hydro-Electric Power Commission of Ontario at Islington, Ontario, working under the direction of the International Niagara Falls Engineering Board. On March 1, 1953, the Board reported to the International Joint Commission recommending the works that should be carried out and submitting an estimate of cost.

The works recommended, and now nearing completion, consist of excavation and fills near the flanks of the Horseshoe Falls to maintain an unbroken curtain of water over the crest at all times, and a control dam in the Chippawa–Grass Island Pool about a mile above the cataract, and therefore above the cascades which extend for rather more than half a mile above the Falls. The control structure will extend 1,482 ft into the river from the face of the abutment on the Canadian shore and will have 13 sluices each with a clear span of 100 ft, separated by piers 14 ft wide and 91 ft long. The Control Dam is being built in sections of two or three gates at a time. Thus only a small part of the river channel will be obstructed at any time by the cofferdam enclosing the section under construction. Four sluices are now completed and operating.

(This paper was originally presented by Mr. Holden at the ASCE Annual Convention in New York, before the Power Division session presided over by R. A. Sutherland, Vice Chairman, Division's Executive Committee.)

Temple B'Nai Amoona. Architect: Eric Mendelsohn, A.I.A. Engineer: Isadore Thompson, San Francisco. Fabricator: Mississippi Valley Structural Steel Co., St. Louis. Erector: Ben Hur Construction Co., St. Louis. General Contractor: I. E. Millstone Construction Co., St. Louis.

→

The temple, assembly wing, and school are tightly arranged around an enclosed garden. The deep columns together with the overhang of roof slab form a system of sunbreaks.

←

Erection of the curved beams. They are 42 in. deep at their bases, tapering to $3\frac{1}{2}$ in. at the edge of the cantilever. The flanges and web were welded together in the shop and each rib shipped to the field in three sections. They were then erected end to end on falsework, and the splices welded.

WASHO Road Test . . .

(This article begins on page 33)

(Continued from page 36)

negotiating for the right-of-way. The Highway Research Board has a small staff on the site primarily concerned with instrumentation and planning for the tremendous job of collecting the test data and reducing it to usable and rational form.

Construction is expected to be started next spring and test traffic should be started in the late summer of 1957.

Thus will be answered some more of the important questions facing serious-minded highway engineers and administrators. Certainly, however, as long as there is to be development of knowledge, this business of road testing will be a continuing thing, and no single project, no matter what its magnitude, can be expected to solve all the problems. The Bates Road Test in 1920 solved some; the Pittsburgh, Stockton and other similar small tests contributed; the Maryland Road Test and WASHO Road Test solved others; and the AASHO Road Test will fill still more of the gaps in our knowledge. It appears now that after completion of the AASHO test, the knowledge of highway researchers will have developed to a point, and instrumentation will have been developed and field tested to a point, where future research could most effectively take the form of many relatively small controlled tests in widely different environments relying heavily on electronic instrumentation and statistical procedures to permit intercorrelation of the findings.

With the expanded highway program practically certain, and such future research certain to be needed, young engineers and students might well consider highway research as a full-time career not only highly useful to society but interesting and rewarding as well.

(This paper was originally presented by Mr. Carey at the ASCE Annual Convention, before the Highway Division session presided over by Roy E. Jorgensen, chairman of the Division's Executive Committee.)

The complete report, "The WASHO Road Test, Part 2: Test Data, Analyses, Findings," Special Report 22 of the Highway Research Board (Publication 360 of the National Academy of Sciences—National Research Council) may be obtained from the Highway Research Board, National Research Council, 2101 Constitution Ave., Washington 25, D.C., at $3.60 each. Part I, describing the project design, construction, and test procedures has been available since 1954.

4300 tons of Bethlehem Steel Sheet-Piling were used in building the two cofferdams at Long Sault. The larger of the two contains cells filled with sand and gravel, about 48 ft in diameter and 42 ft high. The smaller contains eight 60 ft cells, 56 ft high. One half of the dam will be constructed on this site.

Steel cofferdams completed at two locations for St. Lawrence power project

The Long Sault dam will be constructed one-half at a time. The dewatered area enclosed by the cofferdams is to the south or American side of the river. To complete the dam similar temporary cofferdams must be built to span the river (to the right in the photograph).

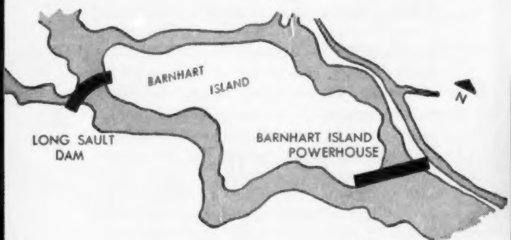
Construction of huge temporary sheet-piling cofferdams at two locations in the International Rapids section of the St. Lawrence River has now been completed. The two cofferdams, one at the site of the projected Long Sault Dam, the other at the Barnhart Island power houses (see map), mark the beginning of major construction on the two-nation St. Lawrence Seaway Power Project.

Development of the hydroelectric power potential of the St. Lawrence is estimated to cost $600 million. The bulk of the work will be in the International Rapids section where the river's flow is 237,000 cu ft per second, as compared to approximately 200,000 cu ft per second of the Niagara River. The project is an integral part of the St. Lawrence Seaway development program which will also open the heart of the continent to 75 per cent of the world's merchant shipping fleet.

More than 16,000 tons of steel sheet-piling have been used in building the cofferdams at Long Sault Dam and Barnhart Island.

At Long Sault, where the dam will be built one-half at a time, the Dravo Corporation has completed diverting the river, constructing two cofferdams of cells and connecting arcs filled with sand and

60 temporary cells with connecting arcs extend for nearly one mile across the river at the Barnhart Island site. The river behind the Barnhart Island power houses will form a pool which will flood about 16 square miles of Canadian farmland and several small communities which must be relocated.



gravel, and dewatering the area. One-half of the dam will be constructed on this area, and then a similar process will be followed to span the river and complete the dam. Over 4000 tons of Bethlehem Sheet-Piling were used in building the two cofferdams.

At Barnhart Island, the Mannix-Raymond Company of Canada has constructed a mile-long cellular cofferdam which spans the river and on this site the twin power houses will be built. Work at both sites was greatly simplified because of studies made on a $200,000 scale model of this section of the river, which accurately duplicated shore lines, bottom contours, the turbulence and flow of the river.

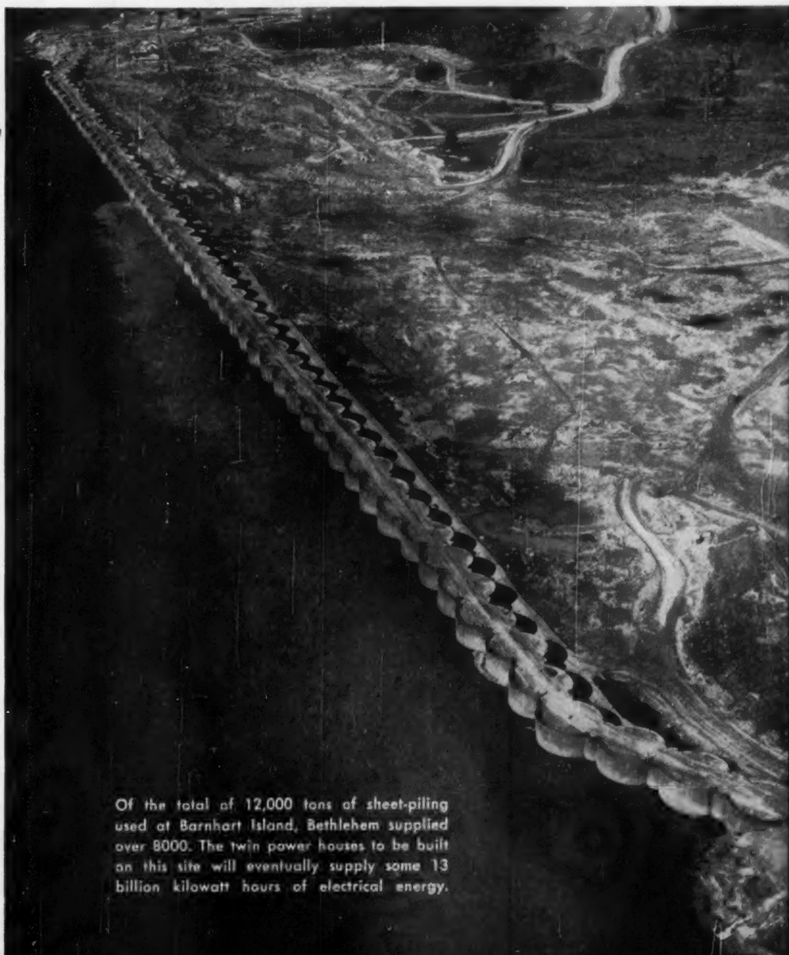
At Barnhart Island some 12,000 tons of sheet-piling were used, more than 8000 tons of which were supplied by Bethlehem.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



Of the total of 12,000 tons of sheet-piling used at Barnhart Island, Bethlehem supplied over 8000. The twin power houses to be built on this site will eventually supply some 13 billion kilowatt hours of electrical energy.

Deceased

(*Continued from page 96*)

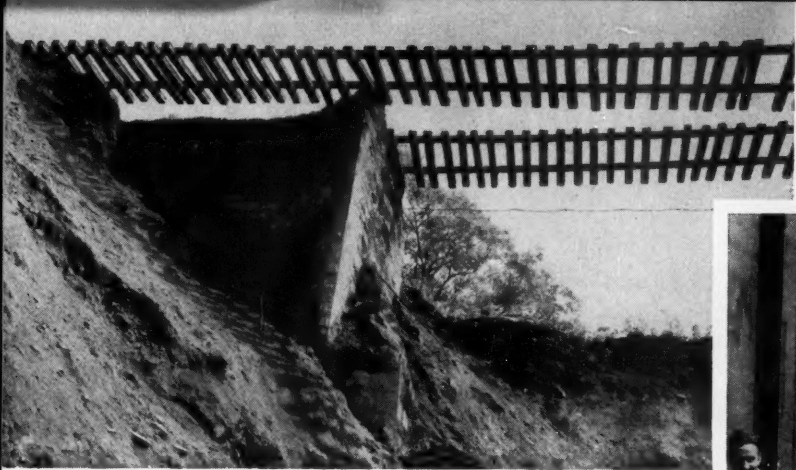
Buffalo Public Works Department. He was managing engineer for the School Department prior to his appointment as Commissioner of Public Works.

Hymen Shifrin (M. '29), age 63, consulting engineer of St. Louis, Mo., died on November 22. After his graduation from Washington University (St. Louis) in 1913, Mr. Shifrin was a junior engineer with the Illinois Highway Department and with the Laclede Christy Clay Products Co., St. Louis. From 1914 to 1933, with the exception of three years in the Army Corps of Engineers, Mr. Shifrin was with the St. Louis Division of Sewers & Paving in various capacities, eventually becoming assistant chief engineer. Since 1933 he had been a partner of ASCE Past-President W.W. Horner in the St. Louis consulting firm of Horner and Shifrin.

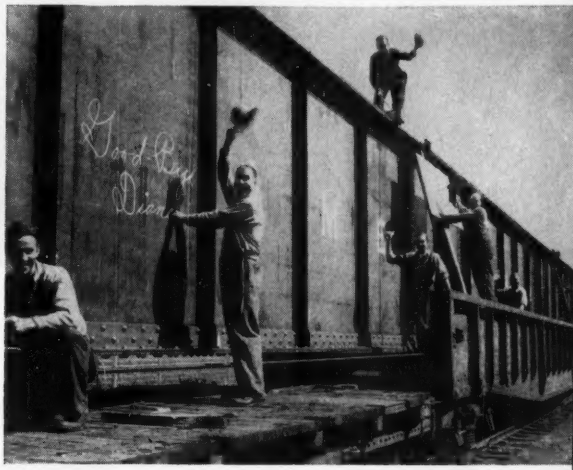
Patrick Benton Smith (A.M. '42), age 52, of Coffeyville, Kans., died there on November 15. Mr. Smith, who attended Kansas State College and Pittsburg State College, was on the engineering staff of the city of Pittsburg, Kans., for eight years, eventually becoming city engineer. Later he was chief engineer of construction for Shulz & Norton, Memphis, Tenn., and city engineer of Coffeyville. He remained with the city for a number of years, serving as manager of utilities and superintendent of the water department until his death.

John Clayton Tracy (M. '20), age 86, professor emeritus of civil engineering at Yale University, New Haven, Conn., died November 1. A graduate of Yale University, class of 1890, he began teaching in the civil engineering department at Yale in 1891 and continued until his retirement in 1936—for the last twenty-one years as head of the department. Professor Tracy made important contributions to the development of the engineering department at Yale, including the establishment of a separate School of Engineering. He was also author of widely used texts on surveying, mechanical drawing, and mathematics.

Bert T. Wake (A.M. '48), age 43, engineer for the Howard Steel Co., Davenport, Iowa, died last February. A 1934 graduate of Iowa State College, Mr. Wake had been construction engineer for the National Park Service; engineer with the American Bridge Co., Ambridge, Pa.; welding engineer for the Ingalls Shipbuilding Corp., Pascagoula, Miss.; and designing engineer for the Carnegie-Illinois Steel Corp.

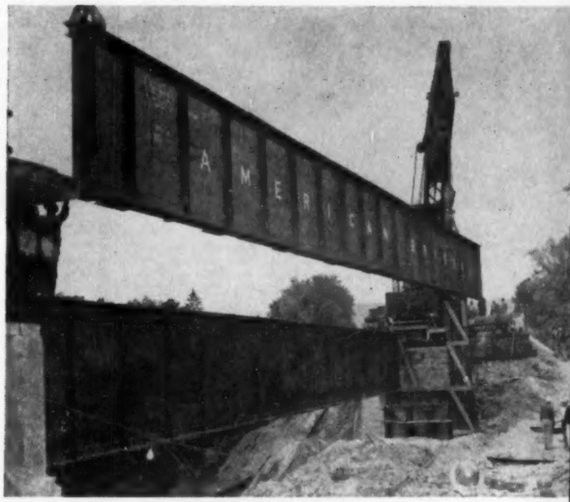


LEFT: This is all that remained after a wall of water swept away a 100-year-old stone arch bridge on the Erie's mainline near Shohola, Pa., as a direct result of Hurricane Diane.



from blueprint to finished bridge in 9 days!

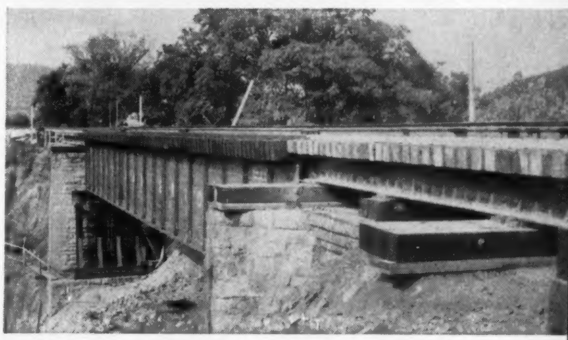
How American Bridge helped the Erie RR meet the emergency of disastrous Diane.



When Hurricane Diane's floods swept down the Delaware Gorge in August 1955, among the many washed-out bridges was the 100-year-old stone arch on the mainline of the Erie Railroad over Panther Creek at Shohola, Pa. *The wreckage was so complete that restoration seemed months away.*

Alerted to the emergency, American Bridge engineers, coöperating with the Erie's engineers, were on the job after the flood. An inspection of existing foundations revealed that they were adequate to support a modern steel girder bridge.

Verbal orders and specifications for replacement plans were received at the Ambridge works of American Bridge on August 31st. The fabricating shops were ready to begin work when the blueprints arrived two days later, although some of the steel for the 50-ton girders was yet to emerge from the open hearths and rolling mills.



Using every means at its command to speed fabrication, American Bridge was able to ship the two 109-foot girders in a record 8 days. The job was completed at the site at 8 A.M., Saturday, September 10th, thus enabling the Erie Railroad to resume traffic over its mainline in just 9 days after American Bridge first received specifications for the big girders.

Here again is another example of how American Bridge serves the railroads. Whether you are in trouble or not, it will pay you to call us in on your bridge fabricating and erecting requirements.

INTERESTING MOTION PICTURES AVAILABLE—"Building for the Nations" and "The Suspension Bridge," two entertaining and educational films, are now available without charge to business, fraternal, and civic organizations, churches, schools and colleges. Write to Pittsburgh office for bookings.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in: AMBRIDGE · ATLANTA · BALTIMORE · BIRMINGHAM · BOSTON · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · ELMIRA GARY · HOUSTON · LOS ANGELES · MEMPHIS · MINNEAPOLIS · NEW YORK · ORANGE, TEXAS · PHILADELPHIA · PITTSBURGH · PORTLAND, ORE. ROANOKE · ST. LOUIS · SAN FRANCISCO · TRENTON · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

AMERICAN BRIDGE

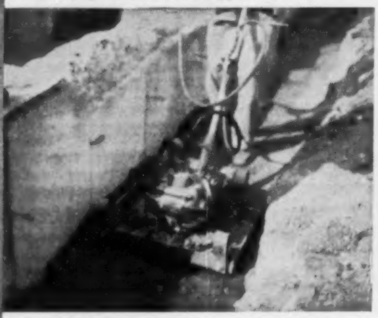
UNITED STATES STEEL

10 LEADS TO BETTER, FASTER RESULTS and BIGGER PROFITS!

MACADAM DENSIFICATION. The Jackson Multiple Compactor consolidates granular soil sub-bases and base courses of sand, gravel, rock or slag in half the time required with equipment of other types.

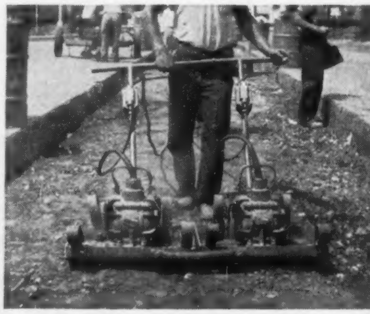
PAVEMENT WIDENING. The Multiple Compactor can be quickly converted to provide in ONE PASS 100% of required density in granular soil sub-bases and rock courses in any widening project.

GRANULAR SOIL FILLS. The Multiple Compactor quickly achieves specified density, gets into places bigger, more expensive equipment cannot reach. Individual units can be detached, operated as manually guided compactors.

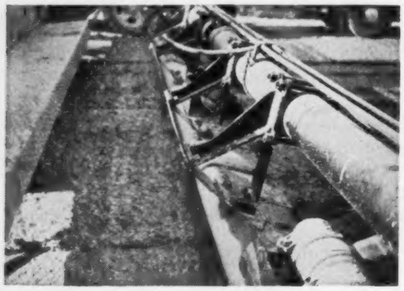


SOIL COMPACTION. Self-propelling, the JACKSON COMPACTOR, with 12" to 26" interchangeable bases, achieves specified density of granular soils in 8" to 10" depths at 2000 sq. ft. per hr. Perfect for bridge and pipe line fills, concrete floor sub-bases, etc.

BLACKTOP WIDENING & PATCHING. The same machine operated from power plant on auto-trailer with pickup for Compactor is most efficient means of blacktop pavement patching, paving walks, drives, etc. Will compact up to 2000 sq. ft. per hr. close to maximum density.



TWIN-UNITS — ONE OPERATOR. With a two-unit, side-by-side or tandem hookup of JACKSON COMPACTORS, one man can readily do the work of two, since the compactors are self-propelling and he has only to guide them.



CONCRETE VIBRATION FOR HIGHWAY AND AIRPORT PAVING

INTERNAL TYPE; super-powered, gives full width internal vibration through full depth of very thick slabs. Saves time, cement; provides greater density and compressive strength. Attaches to finisher or spreader.

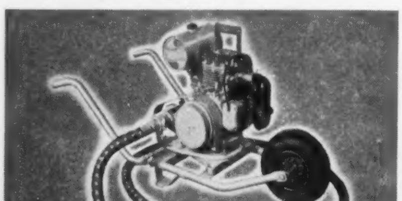
SURFACE TYPE; does perfect job of vibrating all mixes in depths used on highway projects. The owner of a JACKSON Paving Tube can quickly switch from internal to external vibration, or vice versa, at minimum expense.

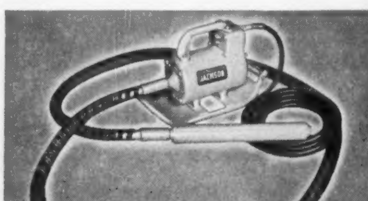
MUNICIPAL PAVING: This vibratory screed strikes off to all crowns, undercuts at curb or sideform, works right up to and around obstructions, is rolled back for second passes on 4 rollers. Most productive and convenient screed made.

FOR SALE OR RENT AT YOUR *JACKSON* DISTRIBUTOR

JACKSON VIBRATORS, INC.

LUDINGTON, MICHIGAN





GENERAL CONSTRUCTION

(Left); 6 H.P. engine-driven, flexible shaft vibrator. Excellent for both thin and thick sections. (Right); 2½ H.P. electric vibrator (for light-socket operation). Handy as a pocket in a shirt, powerful enough to handle all general construction concrete vibration with shafts up to 28'.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 W. 40th ST.	84 E. RANDOLPH ST.	100 FARNSWORTH AVE.	57 POST ST.

This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient non-profit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

CONSTRUCTION ENGINEER, J. M. ASCE; B.S.-C.E.; age 29; 6 years' design and construction; 3 years' construction engineer handling process piping and equipment; 2 years' structural design; one year surveying. Familiar with all phases of construction engineering. Location desired, Midwest. C-98-370-Chicago.

CIVIL ENGINEER, J. M. ASCE; B.S.C.E.; 23; married; 3 years' responsible work experience in all phases of field surveying; specializing in highway and housing developments; including all office problems and calculations; drafting and layout experience for Training Aids Branch U. S. Army. Desires responsible position with progressive company with managerial responsibilities. Willing to branch off to any phase of civil engineering. Available February 15, 1956. Location preferred, N. E. states. C-99.

CIVIL ENGINEER, A. M. ASCE; B.S.E., M.-C.E.; 40, married; wide experience as hydrologist in preliminary investigations for irrigation and hydroelectric developments; intensive surveying experience for same, capable of selecting and training personnel, organizing and supervising large crews, and coordinating all work to the final maps and report stages; 8 years' with Corps of Engineers, 5 years with private firms, 6 years in supervision and construction especially of sanitary and hydraulic structures; fluent Spanish; will consider U.S.A. or overseas. C-100.

CONSTRUCTION ENGINEER, J. M. ASCE; B.C.E.; 27; married; Naval Civil Engineer Corps Officer; 32 months' experience as resident officer in charge of construction of large and small construction projects, estimating, contract administration, maintenance and cost control. Desires position as office engineer or construction contract administrator for large or small firm in New York-New England area. C-101.

CIVIL ENGINEER, A. M. ASCE, with 30 years' high grade, intensive experience in public works administration and in management engineering in public works and industrial fields; desires position of director of public works, city engineer or consulting management engineer. Has successfully administered large public works organizations and directed important management and research projects. C-102.

CIVIL ENGINEER, J. M. ASCE; B.S. in C.E.; 27; single; 2 years as structural engineer in reinforced concrete and steel design; 3 years' experience in shipbuilding industry while serving as engineering specialist officer in the Navy. Available in March, 1956. Willing to travel. Desires California location. C-103.

SOIL MECHANICS ENGINEER; M. ASCE; B.S.C.E., M.S.C.E.; University of Illinois; 42; married; 10 years' experience in highway location and soil stabilization; 5 years as professor of soil mechanics; 6 years as director of soil mechanics and material testing laboratory. Desires position in testing laboratory, or associate professor or highway engineer or foundation engineer. Expects to enter U. S. as immigrant by February, 1956. C-104.

CONSTRUCTION ENGINEER, J. M. ASCE; B.S. in C.E., 1953; 25; single; three years' experience in supervision of large scale building projects and allied works. Desires position in construction firm. Location preferred, U. S. or Middle East. C-105-1230-San Francisco.

Positions Available

STRUCTURAL DESIGNERS AND DRAFTSMEN, graduates, experienced in structural design work for company engaged in the design of a number of important projects such as steam-electric power plants and industrial developments. Recent graduates capable of developing into structural design engineers considered. Salary open. Location, Massachusetts. W-2358.

BRIDGE DESIGNERS, structural engineers, for design of all types of expressway structures and bridges. Positions for bridge designers open in all classes; will also accept structural engineers who desire to enter the bridge field. Will consider experienced detailers and recent graduates. Permanent employment with opportunity for advancement. Salaries, from $4500–$8400 a year, depending upon experience. Location, Pennsylvania. W-2386.

ARCHITECT OR ENGINEER, young, graduate, to supervise construction of store buildings for national concern planning long range expansion program. Considerable traveling. Give starting salary when writing. Location, New York, N.Y. W-2390.

MAINTENANCE CONSTRUCTION ENGINEER, with at least 5 years' supervisory experience covering alteration and maintenance of residential commercial and industrial buildings. Salary, $7500 a year. Location, New York, N.Y. W-2451.

ASSISTANT PROFESSOR AND INSTRUCTOR in civil engineering. Assistant Professor must have special training or experience in the field of sanitary engineering. Appointees must have a broad interest as applied mechanics and strength of materials are taught in the department as well as the civil engineering courses. Opportunity to pursue graduate studies. Position starts Spring semester or Fall, 1956–1957. Location, Midwest. W-2460-C.

ENGINEERS. (a) Assistant City Planner, graduate, with major work in city planning, engineering, architecture, or landscape architecture. Some experinece preferred. Salary, $4050–$4850 a year. (b) City Planner, Master's degree in city planning or college graduation with major work in city planning, engineering, architecture, or landscape architecture. Two years' experience in work involving planning problems. Salary, $4450–$5350 a year. Location, Connecticut. W-2465.

ENGINEERS: (a) Project Engineer, civil graduate with at least 5 years' design and field engineering experience in industrial, municipal and hydraulic fields. Age 30–40. (b) Specifications Engineer and Estimator, Civil or Architectural graduate, with at least five years' varied construction experience covering buildings and heavy construction. Age, 30-40. Salaries, $10,200–$10,800 a year. Duration one year. Location, Greece. F-2484.

SENIOR ARCHITECTURAL ENGINEER experienced in the architectural engineering field and capable of supervising draftsmen and engineers in the design of layout of industrial buildings. Should be graduate architect, and preferably registered. Salary, about $9000 a year. Location, Pennsylvania. W-2520.

JUNIOR CIVIL ENGINEER, 25–35, B.S. in C.E., with minimum of 3 years' design experience in structures, concrete, steel, etc., for an industrial plant. Will assist senior civil engineer in adminis-

(*Continued on page 111*)

(Continued from page 109)

tration of contracts. Take off unit costs, estimating progress, checking layout, checking scheduling with construction. Salary open. Location, State of Washington. W-2535(a).

INSTRUCTOR in civil engineering, to teach in the sanitary and water-supply field. Rank and salary commensurate with experience. Location, Midwest. W-2581(b).

ASSOCIATE PROFESSOR in civil engineering, to take charge of the instruction in surveying. Should be registered engineer with Master's degree. Positions available after January 1, 1956. Location, South. W-2585.

CITY ENGINEER, civil, P.E. for work involving water works, sanitation, streets and city planning. Salary, $6000–$7200 a year. Location, South. W-2586.

DESIGNERS AND DRAFTSMEN on highways, highway structures, steel mills and ceramic plants. Location, Pennsylvania. W-2590.

CHIEF ARCHITECT for large food organization for development of restaurant sites. Future activities of the company include manufacturing operations, motor hotels and industrial feeding operations. Salary open. Location, Washington, D.C. W-2592.

SENIOR STRUCTURAL DESIGNER, under 50, civil or mechanical graduate, with at least 10 years' supervisory experience covering steel towers, bridge and large industrial or process equipment. Company will pay fee. Salary, $10,000–$12,000 a year. Location, Ohio. W2616-D.

ARCHITECTURAL ENGINEER for department head of industrial company on all industrial, architectural, structural, civil and sanitary engineers. Salary open. Location, western Pennsylvania. W-2624.

DESIGNER, civil graduate, with 10 to 15 years' experience in the design of airfields, roads, etc. Work will include design of pavements, grading plans and drainage structures, etc. Salary, $8320 a year. Location, Virginia. W-2627.

STRUCTURAL ENGINEER, qualified to design and supervise miscellaneous steel, concrete and timber structures. Salary, $7000 a year plus benefits. Location, Massachusetts. W-2646.

ADMINISTRATIVE ASSISTANT TO GENERAL MANAGER, for firm of general contractors; graduate civil, 5 to 10 years' experience in heavy and highway construction. Desirable if he had both office and field experience. Salary open. Location, Nebraska. W-2650.

CHIEF DRAFTSMAN, 35–45, in complete charge of an 18-man drafting room making erection and detail drawings of structural steel and miscellaneous and ornamental iron. Salary, $7200 a year. Location, Michigan. W-2651.

FIELD ENGINEER, civil graduate, preferably with P.E. license and resident engineering experience on industrial and process construction projects to supervise layout, schedules, costs, interpretations and revisions of plans and specifications and sub-contracting. Salary, $8400-$10,400 a year. Location, Indiana. W-2652(a).

FIELD ENGINEER, C.E. graduate, young, considerable traveling. Will consider recent graduate or better. Knowledge of steel construction desirable. Duties will include surveying, expediting, plumbing of steel and numerous other duties. For manufacturer of bridges, buildings, etc. Salary, $5520–$6300 a year dependent on experience. Employer will pay placement fee. Headquarters, Chicago. C-4107.

CITY ENGINEER, C.E. graduate or equivalent, 25–50. Experience not required. A knowledge of operation of city water works, sewage disposal plant and maintenance of roads and dealing with public in problems arising in the operation of the city engineering department. Salary, $6600–$7200 a year. Location, Illinois. C-4162.

ASSISTANT OR ASSOCIATE PROFESSOR, M/S.C.E. required, Ph.D. preferred, 30–45, with 3 years' experience teaching, research. Knowledge of two sub-divisions of civil engineering. Will teach undergraduate and graduate subjects in two sub-divisions of civil engineering and help develop research facilities in one of these. Salary, $4500–$5500 for ten months. Employer will negotiate fee. Location, Midwest. C-4227.

ENGINEERING TEACHER, young, M.S. in engineering, teaching and professional experience desirable but not required. Registration in some branch of engineering desirable. Will teach surveying, engineering drawing and mechanics. Rank and salary depends upon education and experience. U. S. citizen desirable but not necessary. Permanent. Location, Hawaii. S-747.

Applications for Admission to ASCE Nov. 19–Dec. 3, 1955

Applying For Member

Franklin Henry Chapin, Detroit, Mich.
Russell E. Crawford, Lombard, Ill.
Carle Michael Davis, Alcoa, Tenn.
Winston Philip Dumbleton, Toronto, Canada.
Maynard Carver Falconer, Sr., Seattle, Wash.
Charles Haviland Fleet, Richmond, Va.
Hyman Herman Gerstein, Chicago, Ill.
William Howard Hopkins, Louisville, Ky.
Fred Adam Houck, Denver, Colo.
Norman Leif Iverson, Saskatoon, Canada.
George Matthew Keranen, Whiting, Ind.
August Eduard Komendant, New York, N. Y.
Victor Joseph Lo Pinto, Long Branch, N. J.
Ellis Preston Lupton, Georgetown, Colo.
Paul Morris, Chattanooga, Tenn.
John Edwin Oldham, Allentown, Pa.
Loren William Olmstead, Buffalo, N. Y.
Murray John Paul, Chicago, Ill.
Lee Thomas Purcell, Paterson, N. J.
Fred Allen Robeson, Mobile, Ala.
Henry Allison Spaulding, Hazard, Ky.
David Yue-Kwong Wong, Hong Kong, China.
Max Zar, Chicago, Ill.

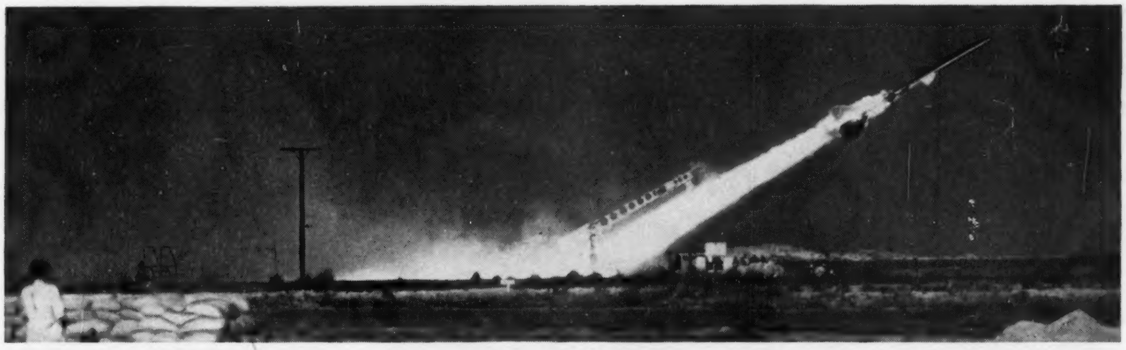
Applying For Associate Member

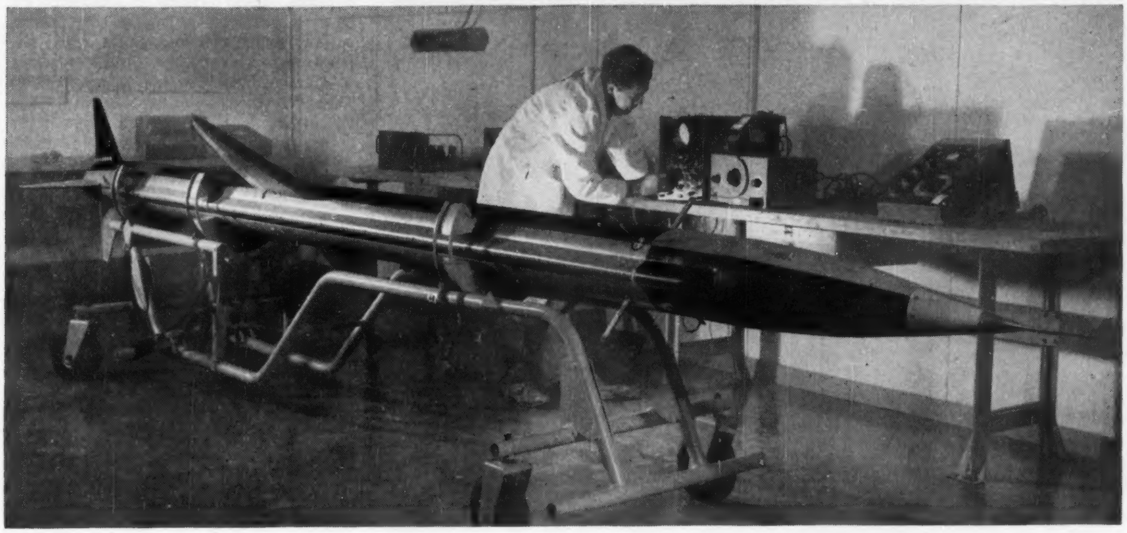
Richard Ackroyd, Hagerstown, Md.
Cornelius Raymond Barrett, Nyack, N. Y.
Henry Stephen Bates, Independence, Calif.
Cecil Dawson Burns, Vicksburg, Miss.
Robert Russell Christiansen, San Francisco, Calif.
Marion Albert Comstock, Louisville, Ky.
Delmer Cecil Dean, Oklahoma City, Okla.
James Clement Ignatius Dooge, Iowa City, Iowa.
Ernest Eugene Gallaher, Tacoma, Wash.
Noel Gordon Lisle Henwood, Oxford, England.
Jagdish Sharan Jain, Washington, D. C.
Joseph Dent Kramer, Pasadena, Calif.
Glebe Alexander Kravetz, New York, N. Y.
Harold Benjamin Leventhal, New York, N. Y.
Malcolm Paul Levy, New York, N. Y.
John E. McDaniel, Jr., Memphis, Tenn.
Jose Heli Moreno Fuenmayor, Venezuela, S. A.
John Albert Reidelbach, Jr., Washington, D. C.
John Byron Stall, Urbana, Ill.
Tadashi Takano, Oahu, Hawaii.
George Edward Tank, Imperial, Calif.
Ervin Edwin White, New York, N. Y.
Gerald Wolkowitz, Belle Harbor, N. Y.

Applying For Junior Member

Asger Stefan Andreasen, Vancouver, B. C., Canada.
Louis Otto Bass, Rock Hill, Mo.
Mauricio Castillo Contoux, Guatemala, C. A.
Edgar Hoover Curtis, South Gate, Calif.
Charles Joseph Doemer, Detroit, Mich.
Paul Johnis, Hyattsville, Md.
Don Albert Linger, State College, N. Mex.
Peter Edward McCurdy, Stockton, Calif.
Robert John McFarlin, Grand Forks, N. D.
Kenneth Gordon Medearis, Albuquerque, N. Mex.
Wayne Robert Miles, Greenville, Miss.
Douglas Cecil Moorhouse, Castro Valley Calif.
Gonzalo de Navacerrada Farias, Madrid, Spain.
James Sheridan Noel, College Station, Tex.
Langdon Wood Owen, Sacramento, Calif.
Richard Calvin Rich, Detroit, Mich.
Sebastian Gilberto Rios, Jr., Panama, C. Z.
James Edwin Roberts, Cambridge, Mass.
Jesus Rafael Tamargo Rodriguez, Havana, Cuba.
James Clarence Sartor, Baton Rouge, La.
Henry Ray Thacker, Kowloon, Hong Kong, China.
Walter Albert Van Orden, Tacoma, Wash.
William Penvel Williams, San Francisco, Calif.

[*Applications for Junior Membership from ASCE Student Chapters are not listed.*]





EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Mechanized Drafting Desk

One of the biggest improvements in drafting tables in 50 years, the Draft-a-Matic is a mechanized drafting desk which permits the draftsman to work more efficiently than ever before in perfect seated comfort. A new device, exclusive with these desks, brings the draftsman's work to him, instead of the draftsman going to the work. Because the desk is adjustable in height and tilt of drafting platform, it can be set in the most desirable position for the person using it, eliminating the need to contort the body to conform to the limitations of conventional drafting tables. In addition to the most efficient drawing surface ever designed, Draft-a-Matic incorporates a reference area plus storage space for instruments, books, drawings and other necessary materials, in one compact unit. **The General Fireproofing Company, CE-1-114, Youngstown, Ohio.**

"Snap-On-Walls"

Simplicity of installation is featured in a revolutionary interior wall system recently developed. Five different extruded aluminum channels form the basis for this unique snap-on, snap-off wall. Included in the extrusions are inside and outside corners, edging, firring and snap-on members. Called Snap-on-Walls, they can transform the interior of any living or working area. Room installation can be accomplished in a few hours with a hammer or screwdriver. By merely snapping panels into or out of position, walls may be replaced, painted or cleaned. **Aluminum Company of America, CE-1-114, 1501 Alcoa Bldg., Pittsburgh, Pa.**

Quick Change Shaft

A new milled slotted offset design on the basic shaft of the Super Hole-a-Matic earth boring machines is now available. Called the Model BSCQ-20, it permits quick changes for earth boring up to 100-ft or more. The new shaft design enables the operator to disengage the motor from the shaft when the machine is being used for deep earth boring. Thus, new extensions are easily added for digging to greater depth, and removed when the machine is being withdrawn. The Super Hole-a-Matic with the quick change basic shaft can also be used for tunneling, and soil testing. **Gen-a-Matic Corp., CE-1-114, 14741 Bessemer St., Van Nuys, Calif.**

Right Angle Back-Hoe

A new back-hoe that digs at right angles to either side of a tractor as well as to the rear is being introduced this month. The new unit has several other unusual characteristics. Designed for operator comfort, it has an extra large, padded seat which revolves with the back-hoe boom and dipper stick so that the operator always faces the direction he is digging. In addition, the operator has excellent vision clear to the bottom of the hole, even when at the maximum depth of 13-ft.

The exclusive right angle feature makes it ideal for cleaning and digging roadside ditches, irrigation and drainage canals, digging around corners of buildings and in crowded areas where a standard back-hoe could not operate. Spoils are dumped far to one side of a hole with sufficient distance between the spoil pile and the hole to prevent back dropping. The back-hoe is sold in combination with the Davis Loader and is mounted directly onto the loader frame. **Mid-Western Industries, Inc., CE-1-114, Wichita, Kansas.**

Portable Heat Wagon

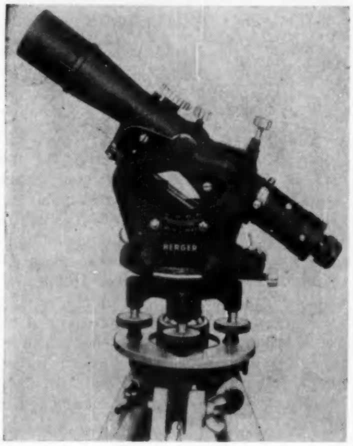
A new product just brought out for general use among contractors is a completely portable Heat Wagon, usable both inside or outside of buildings wherever heat is needed. Light in weight, it can roll through standard 30-in doorways and plugs into any 110-v outlet. Weight is so

Lightweight Heat Wagon

distributed that it balances like a wheelbarrow for pushing. Invaluable for preventing work stoppages and averting damage due to freezing weather, the Heat Wagon can be used to supply clean, warm air for keeping equipment warmed up and ready to go for drying purposes, and for worker comfort. **The Lennox Furnace Company, CE-1-114, 1701 East Euclid Ave., Des Moines 13, Iowa.**

Transit-Level

A COMPLETELY REDESIGNED OPTICAL SYSTEM with a 3-ft short focus for close-quarters surveying highlights the features of a new model builders' convertible transit-level. An internal focusing $10\frac{1}{2}$-in. telescope with 22-power coated optics views an object right side up, and produces a clear, sharp image even in poor lighting over long sights as well as at close distance. Accurate leveling is assured by



Optical Transit-Level

providing a plate level vial in addition to the sensitive telescope vial. The forged brass horizontal circle and the vertical arc have double verniers reading to five minutes. Leveling, clamp and tangent screws are fully dust protected. The convertible is simple to set up for quick readings in leveling, and many other day-to-day building jobs. **C. L. Berger & Sons, Inc., CE-1-115, Williams St., Boston, Mass.**

Crawler-Drawn Scraper

A NEW CRAWLER-DRAWN SCRAPER is now available featuring exclusive new low bowl design. The longer, wider bowl on the new No. 463 affords greater volume and greater heaped capacity, while providing a faster loading rate that continues on to the very end of the loading cycle. Lower sides to the scraper have been designed to give less loading resistance, and more efficient utilization of horsepower. Positive dozer-type ejection assures complete bowl emptying. This cable-operated scraper has a load capacity of 55,000 lb, with a cutting edge which is both "Hi-Electro" hardened and reversible. **Caterpillar Tractor Co., CE-1-115, Peoria, Ill.**

EQUIPMENT, MATERIALS and METHODS

Insulated Concrete-Slabs

PERIMETER INSULATION developed to insulate surface-poured concrete slabs rapidly and economically is announced in a new spun mineral fiber insulation which effectively retards loss of heat at the edges of the slab. This semi-rigid material called Perimsul, exhibits a high thermal efficiency, and, because of its resilience serves as an expansion joint between slab and foundation. It comes in a variety of sizes and thicknesses. **Baldwin-Hill Co., CE-1-116, Building Materials Division, 500 Breunig Ave., Trenton 2, N. J.**

Coal Tar Tape

THE DEVELOPMENT OF A SINGLE-WRAP COAL TAR TAPE FOR PIPE, PIPE JOINTS, FITTINGS AND COUPLINGS has just been announced. This new development offers double-wrap protection from single-wrap application. It permits single-wrapping with only 1/2 in. overlap. Advantages claimed include greater coverage due to the single-wrap features; easier application through an exclusive separator-film which facilitates unrolling and automatically disappears in the application process; savings in time and labor through faster wrapping; and over-all economy in material cost. The new tape is available in rolls of 2 in., 3 in., 4 in., and 6 in. widths. **Tapecoat Company, CE-1-116, 1523 Lyons Street, Evanston, Illinois.**

Industrial Tractor

A NEW RUBBER-TIRED 42-HP WHEEL TRACTOR, Model 300, is designed for use in the industrial field. Powered by an IH C-169 gasoline engine, the tractor weighs 3,820-lb. It is available either in a standard 5-speed transmission or torque amplifier drive. The economical torque amplifier gives 10-speeds forward from 1.5 to 16.7-mph, supplying continuous power to drive wheels even when changing tractor speeds. This new model is available with a Hydra-touch equipment control permitting front and rear-mounted attachments to be controlled simultaneously or individually. Its added weight with ample power enables the operator to use to full advantage such attachments as front-end shovels and backhoes. **International Harvester Company, CE-1-116, 180 North Michigan Ave., Chicago 1, Ill.**

Model 300

Information received before March 15, 1956, will appear in the 1956 Directory

FOR ASCE MEMBERSHIP DIRECTORY

Name ______________________________
Last Name (Please Print) First Name Middle Name

Title or Position ______________________________
Please Print or Type All Information

Name of Firm or Organization ______________________________

Business Address ______________________________
Street
____
City State

Residence Address ______________________________
Street
____
City State

Send Mail and Publications to: ☐ Business Address ☐ Residence Address

Nature of Firm's Business ______________________________
Product, Business or Service (Not for Publication)

Signature ____________________ Date ____________

DO NOT WRITE IN THIS SPACE
ABC
OLD L.S.
NEW L.S.
T.D.
N.C.

EQUIPMENT MATERIALS and METHODS

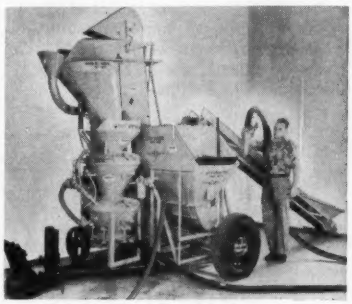
(continued)

Tractor Mounted Ripper

LATEST MODEL IN A LINE OF HEAVY-DUTY ROCK RIPPERS is an extra heavy-duty unit developed specifically for Caterpillar D-9 tractors. Weighing over $6^1/_2$ tons, the HRD-9 Rock Ripper is built to make maximum use of the D-9's tremendously increased power and weight to handle heretofore unrippable materials. Tractor mounting makes it easy to rip in corners or turn around in narrow cuts. The added weight of the ripper on the rear balances front dozer weight, for better traction and improved handling in ripping, pushloading or bulldozing operations. The massive curved ripper shanks produce an underground quivering action that seeks out cracks and weak spots, then shatters rock to easy-loading conditions. **American Tractor Equipment Corporation, CE-1-117, 9131 San Leandro Blvd., Oakland 3, Calif.**

Concrete Gunning Rig

A NEW CONCRETE GUNNING RIG is made up of three basic pieces of equipment used in concrete gunning operations. These are: the nucretor concrete gun, the mix elevator automatic proportioning, dry mixing and elevating machine, and the newest labor-saving item in the assembly, a sand loader. The sand loader operates



Portable Rig

from a power take-off from the drive mechanism of the mix elevator. The rig is thus more automatic and versatile in use. The nucretor is equipped with a new gunning nozzle, which has been designed to provide more efficient gunning of cement and other cementitious materials.

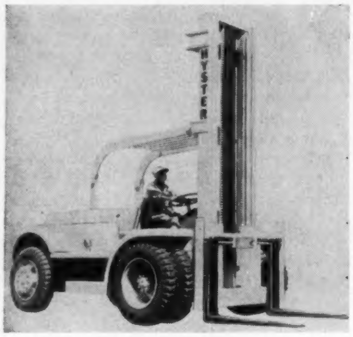
The new rig is designed to be hitched to either the air compressor or the trailer hitch of a truck. This new portable rig is ideally suited for all types of concrete gunning work. **Air Placement Equipment Company, CE-1-117, 1009 West 24th St., Kansas City, Mo.**

EQUIPMENT MATERIALS and METHODS

(continued)

Lift Truck

A COMPACT AND HIGHLY MANEUVERABLE LIFT TRUCK of 20,000-lb capacity at 24-in. load centers is now on the market. Complete driver feel of the ten ton capacity truck in all-weather conditions has been created by convenient, easy to operate controls and an exceptional degree of visibility. Maximum stability and rigidity under capacity loads is the result of an overhead tilting mechanism and new heavier-duty uprights. The TC-200 has a travel speed of more than 20-mph in either forward or reverse. With vacuum-powered brakes, center-point steering, and a sharp outside turning radius of 179-in., a high degree of maneuverability is achieved in this new lift truck. **The Hyster Company, CE-1-118, 2902 N. E. Clackamas St., Portland 8, Ore.**



20,000 lb Capacity

Photocopy Machine

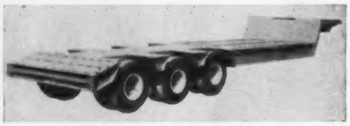
THE FIRST PHOTO-COPY MACHINE designed with self-contained operating units and all supplies in one housing will bring quality photo-copying to the smaller businessman for the first time. As the lightest photocopier on the market today, this 19-lb low-price single unit of unbreakable plastic has the portability of an attaché case. It can make exact copies of anything written, printed, typed, drawn, stamped or photographed in a matter of seconds. The case houses both the exposure and processing photo-copy units, built-in compartments for extra paper and supplies and is complete with carrying handle. The method of operation requires no "wet handling." The automatic roller transports all finished copies back into the hands of the operator. **Cormac Industries, Inc., CE-1-118, 80 Fifth Avenue, New York City.**

EQUIPMENT MATERIALS and METHODS

(continued)

Heavy Duty Trailers

MANUFACTURERS OF HEAVY DUTY TRAILERS for the construction industry have released their new model GTX Triple-Axle Low Boy trailers. Designed to meet the demand for greater legal pay-load, the trailers combine a specially engineered triple-axle arrangement for positive load equalization on all wheels. They are available with 15 or 20-in wheels and with integral or removable goose-necks. Other features include heavy duty tapered roller bearings; air, vacuum or electric brakes, and flat or drop decks. Five sizes provide capacities from 25 through 45 tons. **Transport Trailers, Inc., CE 1-120, Cedar Rapids, Iowa.**



Triple-Axel Trailers

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LITERATURE AVAILABLE

GEARED MOTORS—A four-page folder describes induction, synchronous, universal and reversing motors. Speeds in these motors range from 700-rpm down to one revolution in five minutes, while variations in motor, shaft position, shaft lengths and rotation are unlimited. Each motor has a precision-cut gear; there are no stamped or cast gears. A table of torque ratings is listed for each motor described. The brochure, with specifications and drawings, recommends the proper unit for every application. **Merkle-Korff Gear Co., CE-1-121, 213 North Morgan St., Chicago, 7, Ill.**

SPECIAL FOUNDATION SERVICES—Eight pages of a new brochure explain the use and advantages of Prepakt concrete, Intrusion mortar and grout in the construction and maintenance of foundation and structures. The advantages of these techniques are fully described with particular attention to cofferdam seals, bearing and cut-off piles, structural concrete repairs, and foundation and soil stabilization. **Intrusion-Prepakt, Inc., CE-1-121, Union Commerce Bldg., Cleveland 14, Ohio.**

SEWAGE TREATMENT PLANT CONSTRUCTION—How Uni-Form Panels help reduce concrete forming costs on sewage treatment plant construction is the subject of a four page illustrated folder. In addition to the folder, a set of several engineering drawings showing the application of the Uni-Form Panel System is available. Actual job photographs and job drawings covering circular tanks, Y-walls and other structures that comprise a sewage treatment plant are included. **Universal Form Clamp Co., CE-1-121, 1238 N. Kostner Ave., Chicago 51, Ill.**

PILE REPAIR—A new 8-page illustrated article describing the "Dri-Por" system of pile repair and encasement is now available. Included is a description of the "Dri-Por" K-Box which allows repair of concrete piling in the dry, and also provides for economical, longer-lasting and higher quality pile repairs. **Dri-Por Systems, CE-1-121, Baltimore 26, Md.**

USS TRACKWORK—A comprehensive catalog of 134-pages describes and illustrates USS fabricated crossings, frogs, switches and many other trackwork accessories. Also included is a reference section containing handy mathematical, trigonometric and conversion tables, information of great use to anyone who works with, or buys trackwork. Contractors, plant engineers and designers, purchasing agents and railroad men will find this book a valuable guide to trackwork. Just published, the book is 11 by $8^1/_2$-in. in size. **United States Steel Corporation, CE-1-121, 525 William Penn Place, Pittsburgh 30, Pa.**

From the MANUFACTURERS

ALUMINUM SKYSCRAPER: The new Equitable Life Insurance Company Building of San Francisco uses aluminum curtain wall construction for its entire exterior. Presstite Engineering Company weatherproofed the abutting structural sections with a sealing compound in an easy-to-use tape form. . . **SCHOOL OF CONSTRUCTION "KNOW HOW":** The National School of Heavy Equipment Operations, the first of its kind in the country, has recently opened near Charlotte, N. C., teaching students how to operate heavy earthmoving equipment... **NEW CAT PLANT:** The first overseas produced earth-moving machine bearing the Caterpillar label has just come off the assembly lines in Australia. . . **ALUMNI CITATIONS:** The University of Pennsylvania has cited 23 alumni of its engineering schools for professional achievement and contributions to the public welfare... **54 HOUSEFOOTINGS A DAY:** A Cleveland Trencher is digging trenches for 54 houses a day near Los Angeles for the contracting firm of J. C. Bowles & Son. The excavating job includes trenches for interior and exterior walls, as well as house-service water lines. . . **SPLIT FOR LEHIGH:** The Directors of Lehigh Portland Cement have approved a two-for-one split of the Company's common stock converting the 1,901,560 shares now outstanding to 3,803,120... **WINTER MEETING:** The American Institute of Electrical Engineers will sponsor 400 papers in the 108 sessions scheduled for their general meeting at New York's Hotel Statler January 30 through February 3. . . **EUROPEAN OFFICES OPENED:** Guy B. Panero Engineers of New York are opening offices in Paris and Rome... **SAFETY AWARD:** Portland Cement Association has been presented the National Safety Council award for outstanding safety performance for the second straight year. . . **NEW PRODUCT:** Armco Drainage & Metal Products, Inc., is preparing to market a complete new line of prefabricated truss-type steel buildings. Construction has begun on a million dollar plant to manufacture the prefabricated structures. . . **NEW DEPUTY MAYOR:** Mayor Wagner of New York has appointed John J. Theobald, President of Queens College, as his new deputy mayor. Dr. Theobald was a former Professor of Civil Engineering and member of ASCE. . . **ELECTIONS AND APPOINTMENTS.** Paul D. Smith has been elected executive Vice-President of Intrusion-Prepakt, Inc... The Board of Directors of United States Steel has elected Charles H. Bell a Director of the Corporation. . . A. I. Savin has been named a Vice-President of Merritt-Chapman & Scott Corp. . . Joseph L. Smith has been appointed Deputy Manager of the Atomic Energy Commission's Schenectady Operations. . . **HE RETIRES:** Howard R. Meeker, Chairman of the Board of LeTourneau-Westinghouse has announced his retirement.

PROCEEDINGS AVAILABLE

For Instructions and Key to Abbreviations, see next page. Each member is entitled to 100 free "Proceedings Papers" yearly, ordered from these pages, plus all papers of the Technical Divisions in which he registers. The latter papers will be mailed automatically. To register, mail the enrollment form on page 125 to Society Headquarters. Discussion of a paper will be received during the three full months following the month of issue.

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836. Lunar-Cycle Measurement of Estuarine Flows, by Irvin M. Ingerson. (HY) This paper presents the novel "moving boat method" of making complete current-meter measurements of oscillating tidal flows as well as unique methods of computation yielding instantaneous values of measured freshwater outflows and values of saline interchange. The application of these methods is described; the computation methods result in reliably accurate evaluations of freshwater outflow.

837. Effect of Floods on Transportation by William H. Hobbs. (HY) The effect of floods on transportation is examined and evaluated as regards railroads, highways, pipelines, air fields, and navigable streams. Emphasis is placed on the effect on railroads. The loss of revenue, increased operating costs, and the cost of restoration due to flood damage on railroads are discussed. The advantages of flood protection for transportation and industries are illustrated.

838. Integrating the Equation of Gradually Varied Flow, by Ven Te Chow. (HY) A new method of integrating the equation of gradually varied flow in prismatic channels is presented, including a mathematical derivation, the use of an expanded Bakhmeteff's table, formulas for hydraulic exponents, and curves expediting determination of normal and critical depths. A numerical example and a list of many existing methods of direct integration are also given.

839. The 1951 Kansas City Flood, by Keith R. Barney. (HY) This review of the 1951 flood in the Kansas River Basin emphasizes the effect on industry in the flood plains. The flood caused nearly $500,000,000 damage; industrial buildings suffered in varying degrees, with deposition of silt a major factor affecting final "cleanup." Industry is rebuilding on old locations as the reservoir program is being speeded up.

840. Rainfall Depth—Duration Relationships, by Herbert M. Corn. (HY) The relationships of storm depths, duration, and patterns are considered, and a method of analysis is described which indicates that most short-time intense precipitations behave according to rigorous physical laws. Analyses of storms of varied depths, durations, and patterns are given.

841. Discussion of Proceedings Papers 534, 564, 668, 714. (HY)

842. The Action of Soft Clay along Friction Piles, by H. B. Seed and L. C. Reese. (SM) Data are presented on the increase in supporting capacity with time, the distribution of applied loads along a pile, and the total pressures and pore water pressures in the soil adjacent to a pipe pile driven into soft saturated clay. Soil test data are interpreted to determine the effect of pile driving on the clay and the resistance of the clay to movement of the pile. A procedure is presented for using the results of vane shear tests to determine the load vs. settlement relationship for a pile driven into clay.

843. Discussion of Proceedings Papers 475, 477, 513, 550, 570, 754, 755, 756. (SM) J. D. Parsons and S. D. Wilson closure to 475. No closure to 477. R. B. Peck closure to 513. W. R. Judd closure to 550. M. L. Calhoon closure to 570. D. Wantland on 754. E. Vey, C. W. Fenske, D. T. Harroun on 755. E. M. Buckingham and F. G. Cheney, C. M. Noble, W. G. Weber, Jr., on 756.

844. The Use of Topographic Maps in Highway Location, by C. P. Owens. (SU) This paper reveals the value of topographic maps to the highway engineer. Geological Survey maps, especially newer issues produced by photogrammetric methods, are useful for preliminary highway location studies. The use of photogrammetric methods on a scale that permits actual road plan preparation is described. Ground survey work and drafting can be greatly reduced and highway manpower conserved by these methods.

845. Discussion of Proceedings Papers 277, 407, 575, 722. (SU) No closure to 277. F. J. Guscio closure to 407. J. A. Oliver and F. A. Maloney closure to 575. S. B. Irish on 722.

846. A Preliminary Study of High-Rate Composting, by John S. Wiley and George W. Pearce. (SA) Six 15-gal laboratory, batch-type, mechanical composters used to determine criteria for high-rate composting of organic wastes are described. The physical and chemical tests indicating decomposition during composting are outlined, and typical results are presented. Optimum stirring and aeration rates as well as the percentage of moisture in the initial charge are among the factors included.

847. Experiences with a New Type of Dairy Waste Treatment: Progress Report of the Sanitary Engineering Research Committee, Industrial Waste Section. (SA) The design of a new, two-stage aerobic treatment plant with a Cavitator aeration system is described, and the results obtained in treating the waste from a cheese factory at Hilbert, Wis., are presented.

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848. Discussion of Proceedings Papers 472, 645, 750. (SA) R. Stone closure to 472. G. P. Edwards and W. T. Ingram closure to 645. R. H. Souther and T. A. Alspaugh on 750.

849. Discussion of Proceedings Papers 542, 733, 734, 735. (ST) P. C. Disario, J. S. Podolan, and N. A. Weil closure to 542. J. J. Polivka, A. R. Anderson on 733. B. C. F. Wei on 734. J. Karol on 735.

850. Some Wind Tunnel Design Problems, by W. K. Cook. (ST) The paper concerns the design of the wind tunnels and associated test facilities at an engineering development center in Tullahoma, Tenn. Some of the civil engineers' problems in the selection of materials, the provision of unusual structures meeting exacting aerodynamic requirements, and the provision for wide temperature variations are considered.

851. Elasti-Plastic Design of Single-Span Beams and Frames, by Herbert A. Sawyer, Jr. (ST) After the development of simple expressions for both elastic and plastic flexural deformations, a general, practicable procedure for the solution of restrained single-span beams and frames which makes maximum use of familiar procedures of elastic analysis is presented and examined. The use of this method on beams and frames is illustrated; results of the elasti-plastic analyses of several structures are compared with the results of conventional elastic and plastic analyses of the same structures.

852. Kelly Air Force Base Maintenance Hangar: Planning, by Louis A. Nees. (ST) This hangar-and-shop complex is believed to be the largest in area in the world. Because it is based on the concept of production-line operations and because of its size, its planning and design involved some unusual problems. The paper outlines the basic principles and the steps employed in establishing the size, configurations, and shop layouts.

853. Kelly Air Force Base Maintenance Hangar: Engineering Design Features, by N. H. Aslanian. (ST) This paper provides the essential engineering design features of this large-span, single-story hangar facility and its supporting utilities now under construction for the Air Force.

854. Kelly Air Force Base Maintenance Hangar: Construction Features, by W. H. Fasshauer and C. W. Edwards. (CO) The procedures used in constructing and erecting this new large-span aircraft hangar and its integrated facilities are described. General features of interest including site preparation, caisson foundations, apron slab construction, erection of structural steel, and all the supporting utilities are discussed.

855. Economics of Pipe Line Financing, by Charles J. Hodge. (CO) Benefits which have accrued to the economy as a whole due to the pipe line are noted. After a brief consideration of crude oil, natural gas, and products pipe lines, there are discussed some of the preliminary steps to be taken prior to financing; the paper concludes with a discussion of the approaches to the actual financing.

856. Discussion of Proceedings Papers 505, 632. (CO) C. M. Noble closure to 505. J. Feld closure to 632.

857. Some Aspects of Electronic Surveying in Offshore Areas, by G. A. Roussel. (SU) Electronic methods of surveying are finding increasing application for distance measurements and position fixing over water or inaccessible areas, particularly in the control of aerial photography and petroleum exploration operations. This paper describes various electronic methods with consideration of range, accuracy, and the operating problems associated with those methods.

858. Education of Civil Engineers: Need for Reconsideration, by L. E. Grinter. (BD) This paper reviews the recommendations of the ECPD Committee on Evaluation of Engineering Education, of which the author was chairman. The Committee was charged with determining the changes needed in engineering education (1) to keep pace with the rapid advances that are occurring in science and (2) to provide the next generation with leaders who will be able to apply new scientific discoveries in a creative manner.

859. Education of Civil Engineers: Training for Civil Engineering, by Benjamin A. Whisler. (BD) The present trend of engineering education is toward more technical courses in the basic sciences narrowly pointed toward careers in research and development in the manufacturing industries. Because most graduates still go to field or office positions closely associated with the construction industry, increased attention to basic sciences at the expense of engineering courses is inappropriate for undergraduates. Present curricula, kept up to date in course content, are still most appropriate for the training of prospective civil engineers.

860. Index to Proceedings, Volume 81 (1955), by the Board of Direction. (BD) A subject and author index has been prepared for all Proceedings Papers published in 1955; the numbers covered are 583 to 860. The subject headings used were taken from the names of the technical divisions of the Society; other headings were added when deemed necessary. By use of the author index, it is possible to trace all the discussion that a paper has received.

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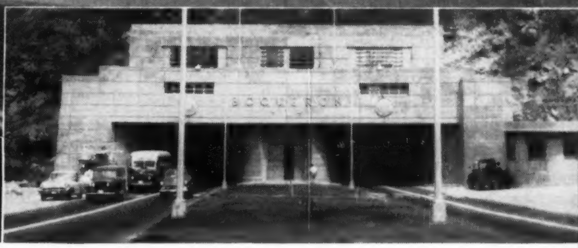

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